Radiological Health Data and Reports

VOLUME 12, NUMBER 11

NOVEMBER 1971

(Pages 541-598)

ENVIRONMENTAL PROTECTION AGENCY

Office of Radiation Programs

INTERNATIONAL NUMERICAL MULTIPLE AND SUBMULTIPLE PREFIXES

Multiples and submultiples	Prefixes	Symbols	Pronunciations
10^{12}	tera	T	tĕr'a
10^{9}	giga	G	ji'ga
10^{6}	mega	M	mĕg'a
10^{3}	kilo	k	kil'o
10^{2}	hecto	h	hĕk'to
10	deka	da	dĕk'a
10^{-1}	deci	d	dĕs'i
10^{-2}	centi	c	sĕn'ti
10^{-3}	milli	m	mil'i
10^{-6}	micro	μ	mi'kro
10^{-9}	nano	n	nan'o
10^{-12}	pico	p	pe'ko
10^{-15}	femto	f	fĕm'to
10^{-18}	atto	a	at'to

SYMBOLS, UNITS, AND EQUIVALENTS

Symbol	Unit	Equivalent
Å	angstrom	10^{-10} meter
a	annum, year	
BeV	billion electron volts	GeV
Ci	curie	3.7×10^{10} dps
cm	centimeter(s)	0.394 inch
cpm	counts per minute	
dpm	disintegrations per minute	
dps	disintegrations per second	
eV	electron volt	1.6×10^{-12} ergs
g	gram(s)	
GeV	giga electron volts	1.6×10^{-3} ergs
kg	kilogram(s)	1,000 g = 2.205 lb.
km^2	square kilometer(s)	
kVp	kilovolt peak	
m^3	cubic meter(s)	
mA	milliampere(s)	
mCi/mi^2	millicuries per square mile	0.386 nCi/m^2 (mCi/km^2)
MeV	million (mega) electron volts	1.6×10^{-5} ergs
mg	milligram(s)	
mi^2	square mile(s)	
ml	milliliter(s)	
mm	millimeter(s)	
nCi/m^2	nanocuries per square meter	2.59 mCi/mi^2
pCi	picocurie(s)	10^{-12} curie = 2.22 dpm
R	roentgen	
rad	unit of absorbed radiation dose	100 ergs/g

The mention of commercial products is not to be construed as either an actual or implied endorsement of such products by the Environmental Protection Agency.

XUM

XUM

RADIOLOGICAL HEALTH DATA AND REPORTS

Volume 12, Number 11, November 1971

Radiological Health Data and Reports, a monthly publication of the Environmental Protection Agency, presents data and reports provided by Federal, State, and foreign governmental agencies, and other cooperating organizations. Pertinent original data and interpretive manuscripts are invited from investigators.

In August 1959, the President directed the Secretary of Health, Education, and Welfare to intensify Departmental activities in the field of radiological health. The Department was assigned responsibility within the Executive Branch for the collation, analysis, and interpretation of data on environmental radiation levels. This responsibility was delegated to the Bureau of Radiological Health, Public Health Service. Pursuant to the Reorganization Plan No. 3 of 1970, effective December 2, 1970, this responsibility was transferred to the Radiation Office of the Environmental Protection Agency which was established by this reorganization.

The Federal agencies listed below appoint their representatives to a Board of Editorial Advisors. Members of the Board advise on general publications policy; secure appropriate data and manuscripts from their agencies; and review those contents which relate to the special functions of their agencies.

Department of Defense
Department of Agriculture
Department of Commerce
Department of Health, Education, and Welfare
Environmental Protection Agency
Atomic Energy Commission

CONTENTS

Page

REPORTS

Strontium-90 in Human Vertebrae in Czechoslovakia 1964–1969 541

Z. Březík

Results of a Survey of X Radiation from Color Television Receivers in the Metropolitan Area of San Juan, Puerto Rico, 1969–1970 547

Commonwealth of Puerto Rico Department of Health

DATA

SECTION I. MILK AND FOOD 553

Milk Surveillance, July 1970 553

Food and Diet Surveillance 562

Radionuclides in Institutional Diet Samples, April–June 1971 563

Estimated Daily Intake of Radionuclides in California Diets, July–December 1970 565

Strontium-90 in Tri-City Diets, January–December 1970, *HASL* 568

CONTENTS—continued

	Page
SECTION II. WATER	571
Gross Radioactivity in Surface Waters of the United States, March 1971	572
Radioactivity in Minnesota Municipal Water Supplies, January–June 1970	574
Tritium Surveillance System, April–June 1971	576
SECTION III. AIR AND DEPOSITION	580
Radioactivity in Airborne Particulates and Precipitation	580
1. Radiation Alert Network, July 1971	581
2. Canadian Air and Precipitation Monitoring Program, July 1971	583
3. Pan American Air Sampling Program, July 1971, *PAHO* and *EPA*	584
4. Plutonium in Airborne Particulates, January–March 1971, *EPA*	584
SECTION IV. OTHER DATA	586
Environmental Levels of Radioactivity at Atomic Energy Commission Installations	586
1. Bettis Atomic Power Laboratory, January–December 1970	586
2. Oak Ridge Area, January–June 1970	589
Reported Nuclear Detonations, October 1971	594
Nuclear Power Reactors in the United States, September 1971	595
Synopses	iii
Guide for Authors	Inside back cover

RADIOLOGICAL HEALTH DATA AND REPORTS

Published under the direction of

Dr. William A. Mills
Acting Deputy Assistant Administrator
for Radiation Programs
Office of Radiation Programs

BOARD OF EDITORIAL ADVISORS

Lt. Col. Ramon Minx
Department of Defense

Dr. Milton W. Lammering
Environmental Protection Agency

Dr. Takuma Tanada
Department of Agriculture

Dr. Carl O. Muehlhause
Department of Commerce

Robert E. Simpson
Department of Health, Education, and Welfare

Dr. Martin B. Biles
Atomic Energy Commission

STAFF

Editor	Samuel Wieder
Managing Editor	Kurt L. Feldmann
Editorial Assistants	Jacqueline J. Copp Mary H. Nesdore
Illustrator	Marylee C. Hill

Address correspondence to the Editor, *Radiological Health Data and Reports*, Office of Radiation Programs, Parklawn 18B-40, Washington, D.C. 20460.

For subscriptions to *Radiological Health Data and Reports*, please use the order form on last page of this issue.

ENVIRONMENTAL PROTECTION AGENCY

William D. Ruckelshaus, Administrator

XUM

Reports

Strontium-90 in Human Vertebrae in Czechoslovakia, 1964-1969

Z. Březík[1]

The Institute of Radiation Hygiene has been conducting a continuous determination of strontium-90 in human vertebrae since the beginning of 1964. Specimens were collected at autopsies of inhabitants of Prague and Middle Bohemia, aged 0–60 years. In the period, 1964–1969 about 1,450 specimens were analyzed and the results divided into 12 age groups. The peak strontium-90 level occurred in 1964 in child group 6–11 months. In the following years, the decreasing trend of strontium-90 values is evident especially in child groups. A frequency histogram of values obtained displays a slightly positive skewness in all years of the study. When plotted, the data indicate a log normal distribution.

Since the beginning of 1964, the Institute of Radiation Hygiene in Prague has carried out determinations of strontium-90 in human vertebrae. The bodies of lumbar vertebrae (in children up to 1 year of age, the thoracic vertebrae too) were collected from deceased inhabitants of Prague and Middle Bohemia, aged 0–60 years. The specimens were taken by pathologists at the Institute of Forensic Medicine and at the Institute of Pathology and Microbiology, Charles University, Prague. All specimens were selected to exclude those whose history reflected a calcium deficiency. About 1,450 specimens of vertebrae have been analyzed from 1964 through 1969.

Analysis

All determinations were made using the method of Bryant et al. (*1*), only radium-226 separation was carried out by the method of precipitation from a homogeneous solution (*2*).

The chemical yields of strontium and yttrium carriers were determined by complexometric titration with EDTA. The indirect complexometric titration procedure was used for the determination of calcium content in bone ash.

The beta activity of yttrium-90 samples was measured using gas flow anticoincidence counters (CE 14, Tracerlab, USA and RA 12, Intertechnique, France). The background of the four counters used was 0.24, 0.99, 0.66 and 1.24 cpm, respectively. The interlaboratory comparison of strontium-90 determination in bones conducted by the International Atomic Energy Agency in Vienna in 1964 showed a good agreement of our results with the expected values.

Discussion

Table 1 lists the levels of strontium-90 in human vertebrae in pCi/g Ca for the 1964–1969 period. The sets of samples are divided into 12 age groups: stillborn and newborn, 0–5 months, 6–11 months, 1, 2, 3, 4, 5–11, 12–18, 19–29, 30–39, 40–60 years of age. From figure 1 it is evident that the course of strontium-90 values depends on age. The peak values are concentrated especially in child groups around 1 year of age. The highest values in these age groups were found in 1964. In the following years the decreasing trend of values is evident. The values for adults above 19 years of age do not vary substantially throughout the whole survey period.

Before calculating the average value for each age group, the outlying observations were tested

[1] Ing. Březík is with the Institute of Hygiene and Epidemiology, Department of Radiation Hygiene, Prague, Czechoslovakia.

Table 1. Strontium-90 in human vertebrae by year of death and age in Czechoslovakia

Group	Age (years)	Strontium-90 to calcium ratio (pCi/g)					
		1964	1965	1966	1967	1968	1969
1	Stillborn and newborn	[a]4.57 ±0.80 (17) 1.44–7.76	4.00 ±0.90 (37) 0.72–10.70	2.21 ±0.40 (30) 0.70–5.05	1.65 ±0.26 (31) 0.64–3.69	—	—
2	0–5 months	5.38 ± .74 (36) 2.17–11.4	3.48 ±0.54 (36) .74–7.21	2.95 ± .46 (47) .57–7.23	2.60 ± .34 (55) .61–5.62	—	—
3	6–11 months	12.3 ±3.0 (7) 7.77–19.3	6.78 ±1.32 (11) 3.34–10.9	4.28 ± .46 (16) 2.95–6.61	3.07 ± .46 (36) .66–6.45	1.41 ±0.09 (1)	—
4	1	8.21 ±1.33 (6) 7.22–11.3	6.86 ±1.86 (10) 1.62–12.2	3.50 ± .66 (9) 1.89–4.91	4.10 ± .86 (20) .71–8.54	2.38 ± .51 (4) 2.07–3.16	3.24 ±0.43 (23) 1.38–5.95
5	2	2.96 ±1.27 (4) 1.63–4.43	3.45 ±1.25 (5) 1.08–4.62	3.26 ± .47 (8) 2.30–4.22	3.82 ± .67 (12) 2.04–6.06	6.38 ±1.42 (2) 5.66–7.11	2.33 ± .44 (9) 1.16–3.30
6	3	3.90 ±1.79 (6) 2.30–7.81	4.20 ±1.15 (8) 2.38–7.20	3.83 ± .81 (11) 2.36–6.59	2.89 ± .52 (12) 1.18–4.64	2.48 ± .39 (5) 2.01–3.03	2.80 ± .73 (10) 1.72–4.84
7	4	4.04 ±2.50 (3) 1.73–6.16	5.46 ±3.43 (3) 2.66–8.68	3.02 ±1.20 (5) 1.62–5.86	2.89 ± .58 (9) 1.69–4.39	4.35 ±1.30 (5) 2.38–6.36	2.96 ± .63 (10) 1.46–5.00
8	5–11	2.73 ± .65 (20) .26–6.21	3.16 ± .46 (21) 1.63–5.58	2.66 ± .24 (21) 1.26–5.14	2.66 ± .35 (33) .85–5.32	1.68 ± .46 (7) 1.21–2.96	2.28 ± .28 (28) 1.05–3.73
9	12–18	3.18 ± .53 (25) .56–6.02	3.72 ± .56 (34) .47–7.23	3.00 ± .33 (38) .81–4.96	2.90 ± .38 (35) .97–6.24	2.20 ± .64 (4) 1.35–2.80	2.52 ± .33 (31) .42–4.25
10	19–29	2.16 ± .43 (18) .89–4.26	2.26 ± .24 (52) .41–4.47	2.10 ± .23 (43) .79–4.60	2.09 ± .23 (39) 1.06–4.15	1.97 ± .57 (2) 1.68–2.26	2.04 ± .48 (7) 1.30–2.92
11	30–39	1.52 ± .41 (13) .31–2.83	2.08 ± .22 (23) 1.29–3.17	1.73 ± .20 (29) .91–3.08	1.94 ± .20 (39) 1.14–3.66	1.43 ± .24 (7) 1.14–2.05	1.80 ± .15 (21) 1.28–2.67
12	40–60	1.63 ± .14 (47) .94–2.70	2.12 ± .17 (66) .44–3.82	1.68 ± .20 (31) .16–2.53	1.80 ± .23 (44) .67–4.36	1.75 ± .16 (45) .95–2.93	1.61 ± .14 (34) .78–2.47

[a] The upper left number is the mean value ±2 S.E. The number in parentheses indicates the number of samples. The lower numbers indicate the range of values found in that group.

XUM

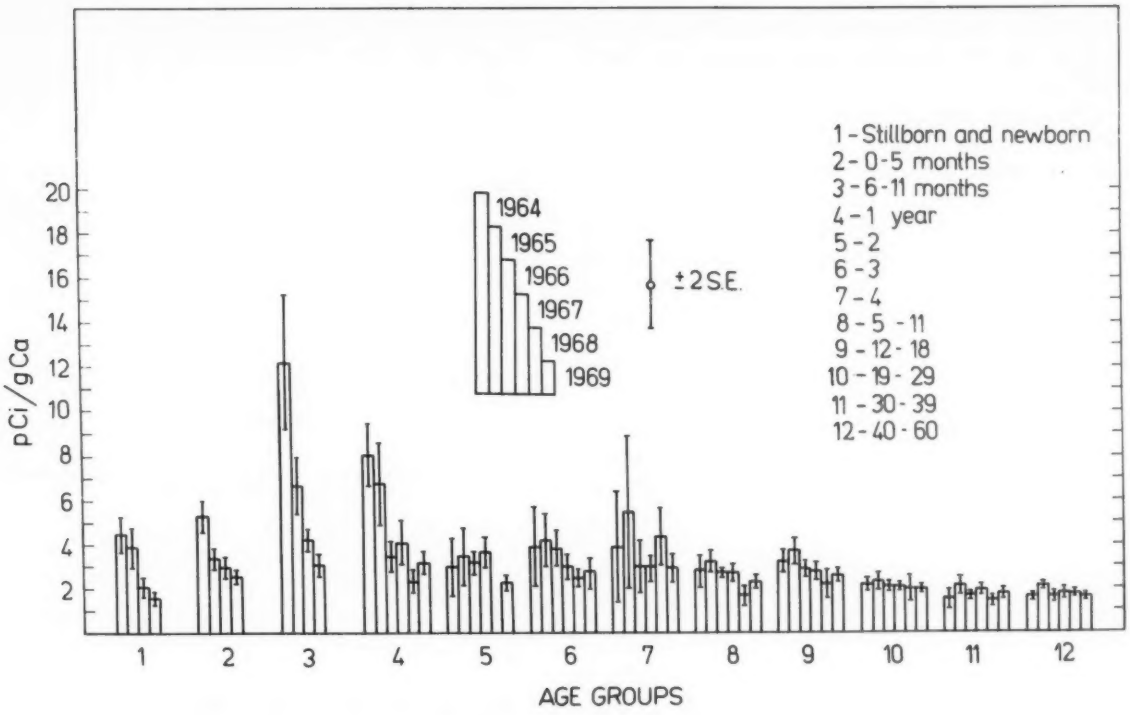

Figure 1. Strontium-90 to calcium ratios in human vertebrae by year of death and age

Table 2. Statistically outlying observations

Year	Group	pCi ^{90}Sr/g Ca	Group	pCi ^{90}Sr/g Ca
1964	1	35.9 ± 1.7	9	8.5 ± 0.5 10.0 ± .4
	2	12.1 ± 1.0 15.1 ± 4.5 17.9 ± .9 32.9 ± 1.8	12	25.9 ± .8
1965	2	10.7 ± 1.4 11.5 ± 1.2 14.0 ± 1.0 17.3 ± 1.0 44.9 ± 2.9	3	17.8 ± 1.0
			5	17.0 ± 1.2
			8	7.8 ± .5
			10	30.7 ± 1.3
1966	1	60.6 ± 4.9	8	6.5 ± .6 19.0 ± 1.2
	2	9.9 ± .8	9	8.5 ± .4
	4	7.4 ± .6		
1967	1	5.6 ± .5 6.3 ± .6 7.8 ± .6	2	8.1 ± .6
1968	4	5.2 ± .4	8	5.9 ± .4
1969	4	12.4 ± .9 17.9 ± 1.2 20.6 ± .8	7	14.4 ± 1.3
			8	5.1 ± .3 8.4 ± .6

according to the method of Grubbs (*3*). The values of the outlying observations are summarized in table 2.

The frequency histograms of strontium-90 to calcium ratios were drawn for individual years of the followup. Figure 2 shows the histogram for the year 1966. In all years the histograms display a slightly positive skewness. A plot of data indicates a log normal distribution of values (figure 3), which is in good agreement with earlier observations on biological materials (*4*).

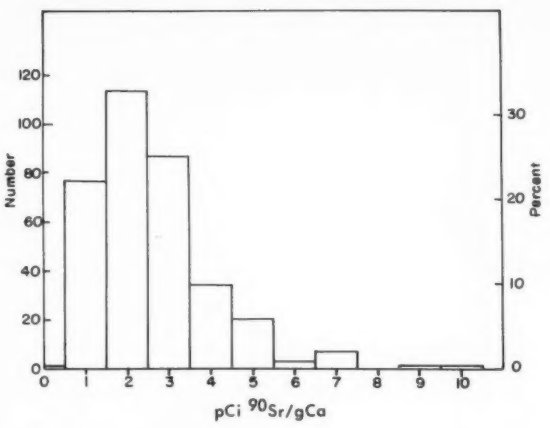

Figure 2. Frequency distribution of strontium-90 to calcium ratios for 1966

Summary

From 1964 through 1969 about 1,450 specimens of human vertebrae were analyzed for strontium-90. The results are divided into 12 age

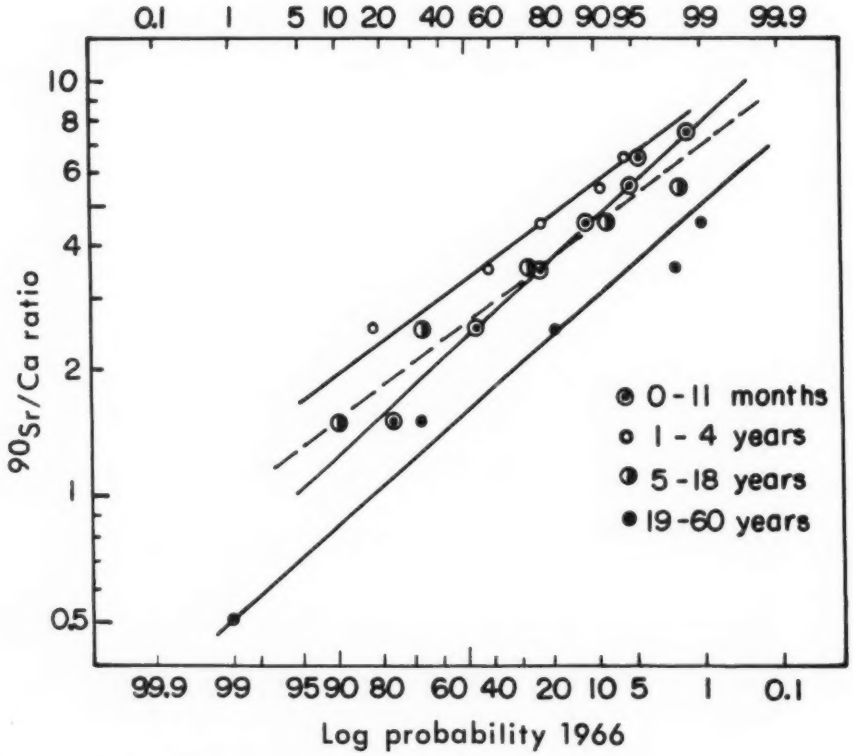

Figure 3. Log probability plot of strontium-90 to calcium ratios by age group for 1966

groups. A review of the data shows that peak strontium-90 levels occurred in most age groups during 1964. In the following years the decreasing trend of strontium-90 values is evident especially in child groups. The strontium-90 values for adults remain practically the same throughout the whole period. The frequency histograms as well as the plot of the data indicate a log normal distribution.

REFERENCES

(1) BRYANT, F. J., A. C. CHAMBERLAIN, G. S. SPICER. Radiostrontium fallout in biological materials in Britain. AERE/HP/R 2056, Harwell, Berks (1956).

(2) GORDON, L., M. L. SALUTSKY and H. H. WILLARD. Precipitation from homogeneous solution, p. 100, John Wiley & Sons, New York (1959).

(3) GRUBBS, F. E. Sample criteria for testing outlying observations. The annals of mathematical statistics 21: 27–58 (1950).

(4) SCHUBERT, J., A. BRODSKY and S. TYLER. The log-normal function as a stochastic model of the distribution of strontium-90 and other fission products in humans. Health Physics 13:1187–1204 (1967).

EDITOR'S NOTE:

It may be of interest to compare the data of Ing. Březík with those obtained during a corresponding period in the United States and some European countries. The data in table 3 were assembled from a number of available sources (*1–5*). It should be noted that the U.S. ratio for strontium-90 to calcium in bone is an average which includes values for "wet" and "dry" areas as defined by the Federal Radiation Council (*6,7*). The spread between the ratios in these areas is substantial and could easily overlap the values observed in the European countries, given comparable latitude and climatic conditions. The log normal distribution of the data in the Czechoslovakia study is apparently characteristic. A similar relationship was reported for the United States (*8*).

REFERENCES

(*1*) Report of the United Nations Scientific Committee on the Effects of Atomic Radiation, Supplement No. 14 (*A*/6314) (1966).

(*2*) Radiological Health Data and Reports. Various issues, volumes 5 to 11 (1964–1970).

(*3*) U.S. ATOMIC ENERGY COMMISSION, Health and Safety Laboratories (HASL) Reports, various issues (1964–1970).

(*4*) FEDERAL REPUBLIC OF GERMANY. Umweltradioaktivitaet und strahlenbelastung (1967).

(*5*) BARATTA, E. J., E. S. FERRI, and M. A. WALL. Strontium-90 in human bones in the United States, 1962–1966. Radiol Health Data Rep 11:183–186 (April 1970).

(*6*) FEDERAL RADIATION COUNCIL. Estimates and evaluation of fallout in the United States from nuclear weapons testing conducted through 1962. Report No. 4 (May 1963).

(*7*) FEDERAL RADIATION COUNCIL. Revised fallout estimates for 1964–1965 and verification of the 1963 predictions. Report No. 6 (October 1964).

(*8*) GAFFNEY, G. W., R. M. HALLISEY, M. S. MILLER, and E. J. BARATTA. Strontium-90 in human bone from infancy to adulthood, 1962–1963. Radiol Health Data Rep 7: 383–386 (July 1966).

Table 3. Average strontium-90 ratios (pCi/g Ca) in human bone United States, Germany, and England

Age group	Year	PHS	AEC[a]	Germany	England
0–4	1963	[b]4.3(44)	3.6(72)	3.7(30)	4.7(165)
	1964	4.3(68)	3.6(64)	5.4(36)	7.9(130)
	1965	3.9(83)	4.3(43)	5.9(19)	7.9(84)
	1966	3.7(67)	2.9(59)	[c]2.9(95)	[d]—
	1967	3.8(111)	2.0(89)	—	—
	1968	3.3(63)	1.9(42)	—	—
	1969	2.6(42)	1.3(125)	—	—
5–19	1963	3.2(163)	1.8(64)	1.4(27)	1.6(74)
	1964	3.2(178)	2.7(67)	2.8(28)	2.2(46)
	1965	2.7(160)	2.9(58)	2.7(13)	2.8(41)
	1966	2.5(193)	2.5(35)	3.0(21)	—
	1967	2.8(299)	2.2(39)	—	—
	1968	2.5(278)	2.9(47)	—	—
	1969	2.2(258)	2.0(50)	—	—

[a] Average of tri-city study (New York City, Chicago, San Francisco); Chicago samples not collected after 1965.
[b] Parentheses give number of samples making up average.
[c] A rather large percentage of the material in this group consisted of specimens 10 days old or less, including fetuses.
[d] Dash means data not available.

XUM

Results of a Survey of X Radiation from Color Television Receivers in the Metropolitan Area of San Juan, Puerto Rico, 1969-1970

Radiological Health Program
Commonwealth of Puerto Rico Department of Health

In 1969–1970, the Puerto Rico Department of Health surveyed 1,276 color television sets for emission of radiation. Only 34 (2.7 percent) of these sets were found to be emitting x radiation in excess of 0.5 mR/h at 5 cm from the surface of the receiver.

It is known that color television receivers may emit x radiation. The National Council on Radiation Protection and Measurements (NCRP) recommended that color television sets not emit x rays with exposure rates above 0.5 mR/h at 5 cm from the accessible surface (*1*). In December 1969, a Federal regulation was adopted making this standard mandatory for all new television receivers.

Various surveys conducted in different States indicate that many color television sets emit x radiation above the recommended value (*2–4*).

In an effort to disclose the magnitude of the problem in Puerto Rico, the Radiological Health Program of the Health Department conducted a similar survey in the Metropolitan Area of San Juan, Puerto Rico. It was divided into two phases: a preliminary and a final one.

The preliminary survey consisted of visits to the manufacturers, distributors, and dealers, as well as home visits, for inspection of television sets. The final survey consisted only of home visits for inspection and reinspection of sets found emitting x radiation above the recommended value, once they were repaired.

A total of 1,276 television sets were surveyed. Of these, 279 were inspected in the visits made to manufacturers, distributors, and dealers, while the rest, 997 television sets, were inspected during home visits. Although the survey has been finished, further calls requesting inspection of television sets are being accepted, and an inspection is being performed by our personnel.

Methods and operations

Visits to manufacturers, distributors, and dealers as well as home visits were started in the summer of 1969. Since only one team was conducting the survey, it took about 1 year to complete the whole survey.

The preliminary survey was divided in two phases. The first phase consisted of visits to manufacturers, distributors, and dealers of color television receivers in Puerto Rico. The second phase and the final survey consisted of visits to homes of television set owners.

The objectives of the visits to the manufacturers, distributors, and dealers were:

1. To make them aware of the problem of x-ray emission from color television receivers.
2. To obtain a list of the owners of color television receivers in Puerto Rico. (At the time of the study there were approximately 60,000 color television sets in Puerto Rico).
3. To make an evaluation of the x-ray emission from the television sets in stock.
4. To have the industry provide corrective service and cooperate with us in finding out what was wrong with the sets that were

found emitting radiation above the recommended value.
5. To determine the most probable factors affecting x-radiation emissions from television sets.

The objectives of the visits to the homes were:

1. To survey all the accessible surfaces of the televisions receivers for x rays.
2. To record (a) the model, serial number, and screen size, (b) the purchase date, (c) the distance from which the set is viewed, and (d) the servicing done to the set before the scanning and by whom it was performed.
3. To instruct the color television viewers of the possible radiation hazards and how to protect themselves.

At first, home visits did not turn out well. Many persons, whose names and addresses we had obtained from the distributors, were not at home when we went to make the survey. In addition, the people's distrust as to the purpose of our visit hampered us from surveying their sets.

In an effort to accomplish our survey satisfactorily, we decided to modify the procedure. We no longer used the list of names provided by the distributors. Instead, a press release was made to inform the public of our survey, and at the same time, inviting them to let us know if they were interested in having their sets surveyed. In this manner, the difficulties which hampered the progress of our survey came to an end.

A list of all the people interested in having their sets surveyed was made and allocated by areas. Every morning, telephone calls were made to those owners living in the metropolitan area which we were to cover. When set owners could not be reached by telephone, we called in person.

Before inspecting the television sets, an interview was conducted with the set owners. In it, special attention was placed on instructing them how to protect themselves from radiation from their television set, for example, keeping at least 6 feet from the set, and having the television set repaired only by expert personnel. After the interview, the inspection was carried out.

In the beginning of this survey, the scannings were performed with a Thyac III Victoreen Geiger-Mueller Counter. Later on, the scannings were performed with another instrument consisting of an array of six Victoreen type 1B85 Geiger-Mueller counters (*5–6*).

Whenever a set was found emitting x radiation above recommended limits, the owner was informed that servicing was needed in order to correct the television receiver. In addition, the distributor was immediately contacted so that appropriate corrections could be made. Prior to beginning the survey, the distributors had agreed that they would repair any sets found emitting x rays above the standards and inform the health department of the corrections and adjustments.

Once these sets were repaired, they were reinspected. The entire procedure was repeated until the television set was found to be within the recommended radiation value.

The preliminary survey

In the preliminary survey we were able to evaluate a total of 575 sets, 279 in the first phase and 296 in the second phase.

The sets surveyed in the first phase of the preliminary survey from the manufacturers, distributors, and dealers (table 1) should not be considered in the final results because there are other possible variables present in the homes where the sets are finally installed which could make them emit x radiation, e.g. variation in the

Table 1. Distribution of color television sets by the x-radiation exposure rate in the first phase of the preliminary survey (in mR/h at 5 cm from the surface of the set)

Brand or manufacturer	0 to ≤0.5
Admiral	10
Andrea	4
Curtis Mathes	19
Emerson	5
General Electric	20
Hotpoint	2
Magnavox	12
Motorola	13
Olympic	2
Packard-Bell	7
Panasonic	5
Penncrest	5
Philco	30
RCA	7
Sears	5
Setchell Carlson	3
Sharp	17
Silvertone	33
Sylvania	6
Toshiba	14
Westinghouse	14
Zenith	46
Grand total	279

line voltage, that would not be found in the sets provided by the manufacturers, distributors, and dealers.

Of those surveyed in the second phase of the preliminary survey, eight were found emitting x rays above the recommended value (table 2). Three of them emitted x rays with exposure rates above 0.5 mR/h but less than 1.0 mR/h. The other five sets emitted x rays above 1.0 mR/h, but not beyond 5.0 mR/h. These emissions were detected at the anterior surface in two sets, at the posterior surface in two sets, at the left (of the viewer) lateral surface in two sets, at the top surface in one set and at the top and right lateral surfaces in one set.

Table 2. Distribution of color television sets by the x-radiation exposure rate in the second phase of the preliminary survey (in mR/h at 5 cm from the surface of the set)

Brand or manufacturer	Total	0 to ≤0.5	>0.5 to <1.0	≥1.0 to 5.0
Admiral	11	11	0	0
Andrea	4	4	0	0
Curtis Mathes	27	26	0	1
Emerson	5	5	0	0
Del Monico	1	1	0	0
General Electric	40	39	0	1
Heathkit	1	1	0	0
Hotpoint	2	2	0	0
Magnavox	11	11	0	0
Motorola	4	4	0	0
Olympic	2	2	0	0
Packard-Bell	2	2	0	0
Panasonic	18	18	0	0
Pennecrest	5	5	0	0
Philco	9	8	1	0
RCA	11	10	1	0
Sears	43	42	1	0
Setchell Carlson	5	5	0	0
Sharp	2	2	0	0
Silvertone	19	19	0	0
Sylvania	17	17	0	0
Toshiba	13	12	0	1
True-Tone	1	1	0	0
Westinghouse	17	17	0	0
Zenith	26	24	0	2
Grand total	296	288	3	5

All eight television sets found emitting radiation above allowable standards were reported to the distributors for corrective service; repair reports were received from the distributors. In five of the television sets, the high voltage had to be adjusted; the highest voltage excess (above normal operating conditions) found was 4.0 kV. The shunt regulator was found to be the only source of excess emission in two sets, and the picture tube in one set. The corrective servicing for sets with x-radiation emissions above 0.5 mR/h consisted of adjustments of high voltage and replacement of component parts. A total of two shunt regulators and one picture tube were replaced.

It was found that out of the 296 sets inspected, 117 owners of color television receivers watched their sets from distances of less than 6 feet. One of the sets emitted radiation at a higher exposure rate than recommended. The remaining 179 owners kept distances greater than 6 feet but not farther than 10 feet. Seven television sets of this second group emitted radiation at a rate greater than 0.5 mR/h.

Finally we observed that only a small fraction (1.7 percent) of the population visited in this preliminary survey serviced their own television receivers. The majority of this small fraction were television repairmen.

The final survey

In the final survey, a total of 701 television sets were surveyed. Of these 675 were found to be emitting radiation between 0 and 0.5 mR/h (table 3).

Only 26 television sets were found emitting x radiation above the recommended value (table 3). Of these 26 television sets, 22 were emitting radiation at levels below 1.0 mR/h, and four at or above 1.0 mR/h. The highest value found was 1.6 mR/h. Of the 26 sets found emitting x radiation, 10 had the highest level of radiation emission at

Table 3. Distribution of color television sets by the x-radiation exposure rate in final survey (in mR/h at 5 cm from the surface of the set)

Manufacturer	Total	0 to ≤0.5	>0.5 to <1.0	≥1.0 to 5.0
Admiral	26	24	2	0
Curtis Mathes	94	90	4	0
Dumont	2	2	0	0
Emerson	8	8	0	0
General Electric	101	99	2	0
Heathkit	2	2	0	0
Hotpoint	5	5	0	0
Magnavox	27	25	1	1
Motorola	5	5	0	0
Nivico	1	1	0	0
Olympic	2	2	0	0
Packard-Bell	10	9	0	1
Panasonic	25	24	1	0
Pennecrest	22	22	0	0
Philco	13	13	0	0
RCA	27	24	3	0
Sears	50	44	5	1
Setchell Carlson	3	3	0	0
Sharp	6	6	0	0
Silvertone	86	86	0	0
Singer	3	3	0	0
Sony	1	1	0	0
Sylvania	50	49	1	0
Toshiba	22	22	0	0
Westinghouse	44	43	0	1
Zenith	66	63	3	0
Grand total	701	675	22	4

the posterior surface, seven at the anterior surface, one at the bottom, four at the left lateral surface, three at the top and one at the right lateral surface.

All 26 television sets found to be emitting radiation above normal levels were reported to the distributors for corrective service; repair reports were received from the distributors. In 16 television sets, only the voltage had to be adjusted; the highest voltage excess found above normal operating conditions was 6.0 kV. The shunt regulator was found to be the only source of excess emission in seven television sets, the picture tube in one set, the rectifier tube in one set, and a combination of voltage and picture tube in one set.

The corrective servicing for those sets with x-radiation emissions above 0.5 mR/h consisted of replacement of components and/or adjusting the operating high voltage to recommended operating levels. A total of seven shunt regulators, one rectifier tube, and two picture tubes were replaced.

It was found that 55 owners of television sets watched their sets from a distance of less than 6 feet. Three of the sets were emitting x radiation above 0.5 mR/h. It was also found that only 1.4 percent of the owners service their television sets.

Table 4. Distribution of color television sets by the x-radiation exposure rate in home visits of preliminary and final surveys (in mR/h at 5 cm from the surface of the set)

Manufacturer	Total	0 to ≤0.5	>0.5 to <1.0	≥1.0 to 5.0
Admiral	37	35	2	0
Andrea	4	4	0	0
Curtis Mathes	121	116	4	1
Del Monico	1	1	0	0
Dumont	2	2	0	0
Emerson	13	13	0	0
General Electric	141	138	2	1
Heathkit	3	3	0	0
Hotpoint	7	7	0	0
Magnavox	38	36	1	1
Motorola	9	9	0	0
Nivico	1	1	0	0
Olympic	4	4	0	0
Packard-Bell	12	11	0	1
Panasonic	43	42	1	0
Pennerest	27	27	0	0
Philco	22	21	1	0
RCA	38	34	4	0
Sears	93	86	6	1
Setchell Carlson	8	8	0	0
Sharp	8	8	0	0
Silvertone	105	105	0	0
Singer	3	3	0	0
Sony	1	1	0	0
Sylvania	67	66	1	0
Toshiba	35	34	0	1
True-tone	1	1	0	0
Westinghouse	61	60	0	1
Zenith	92	87	3	2
Grand total	997	963	25	9

Summary

A total of 1,276 television sets was surveyed. Of these, 279 were inspected at manufacturers, distributors and dealers. The rest (997 television sets) were inspected in home visits. Of these 997 television sets, 963 television sets were emitting x radiation at or below 0.5 mR/h (table 4).

Of those television sets inspected at manufacturers, distributors, and dealers, none was found emitting radiation above the recommended level. Of those inspected in home visits, only 34 were found emitting x radiation above the recommended value (table 4). The highest value found was 1.6 mR/h. Of these 34 sets, 12 had the highest level of radiation emission measured at the posterior surface, nine at the anterior, six at the left lateral, four at the top, one at the bottom, one at the top and right lateral, and one at the right lateral surface (table 5).

Discussion

The purpose of this survey was to evaluate the magnitude of the problem of color television sets emitting x radiation in the metropolitan area of San Juan, Puerto Rico. Although different makes and models were surveyed, no relationship can be established between makes and models and x-radiation emission. That requires a greater sample and a better representation of each make and model.

Out of the 997 television sets surveyed in home visits, only 34 were found emitting above 0.5 mR/h, which represents 3.4 percent of the total surveyed. This percentage is lower than those found in other surveys (*2–4*).

The results obtained in our survey confirm that industry is capable of producing television sets within the recommendations made by the NCRP. Even so, further improvements should be made in order to keep to a minimum the chances of unnecessary x-radiation emission.

Conclusions

1. X-ray emission from color television sets occurs in Puerto Rico and was observed in various makes and models of the 1,273 sets surveyed.
2. Only 3.4 percent of the television sets surveyed

XUM

Table 5. Distribution of color television sets found in the preliminary and final surveys emitting radiation above the recommended level (including surface measured and source of radiation)

Manufacturer	Level of emission (mR/h)	Surface	Source of radiation
Admiral	0.8	Anterior	Shunt regulator
	.6	Right lateral	High voltage
Curtis Mathes	.6	Posterior	Picture tube
	.7	Posterior	Picture tube
	.6	Bottom	Shunt regulator
	.7	Left lateral	High voltage
	1.0	Posterior	Picture tube and high voltage
General Electric	.6	Posterior	Shunt regulator
	1.4	Posterior	High voltage
	.6	Posterior	High voltage
Magnavox	1.6	Left lateral	High voltage
	.6	Top	High voltage
Packard-Bell	1.5	Anterior	Picture tube
Panasonic	.6	Top	High voltage
Philco	.5	Anterior	High voltage
RCA	.6	Left lateral	Shunt regulator
	.6	Top	High voltage
	.6	Anterior	High voltage
	.6	Anterior	High voltage
Sears	.8	Top and right lateral	Rectifier tube
	1.0	Top	High voltage
	.6	Posterior	High voltage
	.6	Posterior	High voltage
	.6	Posterior	High voltage
	.6	Posterior	High voltage
	.7	Posterior	High voltage
Sylvania	.8	Left lateral	Shunt regulator
Toshiba	1.0	Left lateral	Shunt regulator
Westinghouse	1.0	Posterior	High voltage
Zenith	.6	Anterior	High voltage
	1.0	Anterior	High voltage
	.5	Anterior	High voltage
	1.0	Anterior	High voltage
	.7	Left lateral	Shunt regulator

were found to be emitting x rays above 0.5 mR/h.

3. Operating high voltage affects production and emission of x radiation from components.
4. The main sources of x radiation are excessive high voltage, the shunt regulator, the rectifier tube, and the picture tube.
5. Proper servicing reduces the x radiation to a permissible level.

Acknowledgments

The Radiological Health Program wishes to express its appreciation for the assistance in preparing this survey to the Secretary of Health, Dr. Ernesto Colón Yordán; the Deputy Secretary of Health, Dr. Carlos E. Náter; and the former Assistant Secretary for Environmental Health, Dr. Angel Alberto Colón, for their encouragement and the Bureau of Radiological Health, U.S. Public Health Service, for permitting us the use of equipment for measuring x radiation.

REFERENCES

(1) THE NATIONAL COMMITTEE ON RADIATION PROTECTION AND MEASUREMENTS. Recommendations for color T.V. receivers with x-radiation emission. Radiology 173:22 (1960).

(2) TECHNICAL SERVICES BRANCH, NATIONAL CENTER FOR RADIOLOGICAL HEALTH. A survey of x-radiation from color television sets in Washington, D.C. Metropolitan area, TSB No. 3, PB 178-810. PHS, National Center for Radiological Health, Rockville, Md. 20852 (March 1968).

(3) TECHNICAL SERVICES BRANCH, NATIONAL CENTER FOR RADIOLOGICAL HEALTH. A pilot survey of x-radiation from color television receivers in Pinellas County, Florida, TSB No. 2, PB 178-809. PHS, National Center for Radiological Health, Rockville, Md. 20852 (June 1968).

(4) SMITH, D. R. et al. X-radiation control programs in the color television industry, Report DEP 69-1, PB 185-979. PHS, Bureau of Radiological Health, Rockville, Md. 20852 (March 1969).

(5) STOMS, R. K. and E. KUERZE. Instrument for measurement of x-ray emission from television sets, Report TSB No. 1, PB 178-808. PHS, National Center for Radiological Health, Rockville, Md. 20852 (January 1968).

(6) RECHEN, H. J. L. et al. Calibration and energy dependence of the EPRL x-ray survey meter. Technical Papers; Conference on Detection and Measurement of X-radiation from Color Television Receivers, Conference held in Washington, D.C., March 28-29, 1968. PHS, National Center for Radiological Health, Rockville, Md. 20852, pp. 175-184.

XUM

SECTION I. MILK AND FOOD

Milk Surveillance, July 1971

Although milk is only one of the sources of dietary intake of environmental radioactivity, it is the food item that is most useful as an indicator of the general population's intake of radionuclide contaminants resulting from environmental releases. Fresh milk is consumed by a large segment of the population and contains several of the biologically important radionuclides that may be released to the environment from nuclear activities. In addition, milk is produced and consumed on a regular basis, is convenient to handle and analyze, and samples representative of general population consumption can be readily obtained. Therefore, milk sampling networks have been found to be an effective mechanism for obtaining information on current radionuclide concentrations and long-term trends. From such information, public health agencies can determine the need for further investigation or corrective public health action.

The Pasteurized Milk Network (PMN) sponsored by the Office of Radiation Programs, Environmental Protection Agency, and the Office of Food Sanitation, Food and Drug Administration, U.S. Public Health Service, consists of 63 sampling stations: 61 located in the United States, one in Puerto Rico, and one in the Canal Zone. Many of the State health departments also conduct local milk surveillance programs which provide more comprehensive coverage within the individual State. Data from 15 of these State networks are reported routinely in *Radiological Health Data and Reports*. Additional networks for the routine surveillance of radioactivity in milk in the Western Hemisphere and their sponsoring organizations are:

Pan American Milk Sampling Program (Pan American Health Organization and U.S. Environmental Protection Agency)—5 sampling stations

Canadian Milk Network (Radiation Protection Division, Canadian Department of National Health and Welfare)—16 sampling stations.

The sampling locations that make up the networks presently reporting in *Radiological Health Data and Reports* are shown in figure 1. Based on the similar purpose for these sampling activities, the present format integrates the complementary data that are routinely obtained by these several milk networks.

Radionuclide and element coverage

Considerable experience has established that relatively few of the many radionuclides that are formed as a result of nuclear fission become incorporated in milk (*1*). Most of the possible radiocontaminants are eliminated by the selective metabolism of the cow, which restricts gastrointestinal uptake and secretion into the milk. The five fission-product radionuclides which commonly occur in milk are strontium-89, strontium-90, iodine-131, cesium-137, and barium-140. A sixth radionuclide, potassium-40, occurs naturally in 0.0118 percent (*2*) abundance of the element potassium, resulting in a specific activity for potassium-40 of 830 pCi/g total potassium.

Two stable elements which are found in milk, calcium and potassium, have been used as a means for assessing the biological behavior of metabolically similar radionuclides (radiostron-

Figure 1. Milk sampling networks in the Western Hemisphere

tium and radiocesium, respectively). The contents of both calcium and potassium in milk have been measured extensively and are relatively constant. Appropriate values and their variations, expressed in terms of 2 standard deviations (2σ), for these elements are 1.16 $\pm$ 0.08 g/liter for calcium and 1.51 $\pm$ 0.21 g/liter for potassium. These figures are averages of data from the PMN for May 1963–March 1966 (*3*) and were determined for use in general radiological health calculations or discussions.

Accuracy of data from various milk networks

In order to combine data from the international, national, and State networks considered in this report, it was first necessary to determine the accuracy with which each laboratory is making its determinations and the agreement of the measurements among the laboratories. The Analytical Quality Control Service of the Office of Radiation Programs conducts periodic studies to assess the accuracy of determinations of radionuclides in milk performed by interested radiochemical laboratories. The generalized procedure of making such a study has been outlined previously (*4*).

The most recent study was conducted during May–July 1970, with 28 laboratories participating in an experiment on milk samples containing known concentrations of strontium-89, strontium-90, iodine-131, cesium-137, and barium-140 (*5*). Of the 18 laboratories producing data for the networks reporting in *Radiological Health Data and Reports*, 13 participated in the experiment.

The accuracy results of this experiment are shown in table 1. In general, considerable improvement is needed, especially in the accuracy measurements. These possible differences should be kept in mind when considering the integration of data from the various networks.

Development of a common reporting basis

Since the various networks collect and analyze samples differently, a complete understanding of several parameters is useful for interpreting the data. Therefore, the various milk surveillance networks that report regularly were surveyed for information on analytical methods, sampling and analysis frequencies, and estimated analytical errors associated with the data.

In general, radiostrontium is collected by an ion-exchange technique and determined by beta-particle counting in low-background detectors, and the gamma-ray emitters (potassium-40, iodine-131, cesium-137, and barium-140) are determined by gamma-ray spectroscopy of whole milk. Each laboratory has its own modifications

Table 1. Distribution of mean results, quality control experiment

Isotope and known concentration	Number of laboratories in each category			
	Acceptable[a]	Warning level[b]	Unacceptable[c]	Total
Strontium 89: High (258 pCi/liter)	7 (44%)	1 (6%)	8 (50%)	16
Low (15 pCi/liter)	11 (69%)	3 (19%)	2 (12%)	16
Strontium-90: Intermediate (79.4 pCi/liter)	13 (57%)	4 (17%)	6 (26%)	23
Low (32.0 pCi/liter)	5 (25%)	4 (20%)	11 (55%)	20
Iodine-131: High (507 pCi/liter)	18 (67%)	2 (7%)	7 (26%)	27
Low (49 pCi/liter)	16 (64%)	3 (12%)	6 (24%)	25
Cesium-137 High (259 pCi/liter)	20 (74%)	3 (11%)	4 (15%)	27
Low (53 pCi/liter)	17 (66%)	5 (19%)	4 (15%)	26
Barium-140: High (302 pCi/liter)	18 (67%)	2 (7%)	7 (26%)	27
Low (33 pCi/liter)	23 (92%)	0	2 (8%)	25

[a] Measured concentration equal to or within 2σ of the known concentration.
[b] Measured concentration outside 2σ and equal to or within 3σ of the known concentration.
[c] Measured concentration outside 3σ of the known concentration.

and refinements of these basic methodologies. The methods used by each of the networks have been referenced in earlier reports appearing in *Radiological Health Data and Reports.*

A previous article (*6*) summarized the criteria used by the State networks in setting up their milk sampling activities and their sample collection procedures as determined during a 1965 survey. This reference and an earlier data article for the particular network of interest may be consulted should events require a more definitive analysis of milk production and milk consumption coverage afforded by a specific network.

Many networks collect and analyze samples on a monthly basis. Some collect samples more frequently but composite the several samples for one analysis, while others carry out their analyses more often than once a month. Many networks are analyzing composite samples on a quarterly basis for certain nuclides. The frequency of collection and analysis varies not only among the networks but also at different stations within some of the networks. In addition, the frequency of collection and analysis is a function of current environmental levels. The number of samples analyzed at a particular sampling station under current conditions is reflected in the data presentation. Current levels for strontium-90 and cesium-137 are relatively stable over short periods of time, and sampling frequency is not critical. For the short-lived radionuclides, particularly iodine-131, the frequency of analysis is critical and is generally increased at the first measurement or recognition of a new influx of this radionuclide.

The data in table 2 show whether raw or pasteurized milk was collected. An analysis (*7*) of raw and pasteurized milk samples collected during January 1964 to June 1966 indicated that for relatively similar milkshed or sampling areas, the differences in concentration of radionuclides in raw and pasteurized milk are not statistically significant (*7*). Particular attention was paid to strontium-90 and cesium-137 in that analysis.

Practical reporting levels were developed by the participating networks, most often based on 2-standard-deviation counting errors or 2-standard-deviation total analytical errors from replicate analyses (*3*). The practical reporting level reflects analytical factors other than statistical radioactivity counting variations and will be used as a practical basis for reporting data.

The following practical reporting levels have been selected for use by all networks whose practical reporting levels were given as equal to or less than the given value.

Radionuclide	Practical reporting level (pCi/liter)
Strontium-89	5
Strontium-90	2
Iodine-131	10
Cesium-137	10
Barium-140	10

Some of the networks gave practical reporting levels greater than those above. In these cases the larger value is used so that only data considered by the network as meaningful will be presented. The practical reporting levels apply to the handling of individual sample determinations. The treatment of measurements equal to or below these practical reporting levels for calculation purposes, particularly in calculating monthly averages, is discussed in the data presentation.

Analytical error or precision expressed as pCi/liter or percent in a given concentration range has also been reported by the networks (*3*). The precision errors reported for each of the radionuclides fall in the following ranges:

Radionuclide	Analytical errors of precision (2 standard deviations)
Strontium-89	1–5 pCi/liter for levels <50 pCi/liter; 5–10% for levels ≥ 50 pCi/liter;
Strontium-90	1–2 pCi/liter for levels <20 pCi/liter; 4–10% for levels ≥ 20 pCi/liter;
Iodine-131, Cesium-137, Barium-140	4–10 pCi/liter for levels <100 pCi/liter; 4–10% for levels ≥ 100 pCi/liter.

For iodine-131, cesium-137, and barium-140, there is one exception for these precision error ranges: 25 pCi/liter at levels <100 pCi/liter for Colorado. This is reflected in the practical reporting level for the Colorado milk network.

Federal Radiation Council guidance applicable to milk surveillance

In order to place the U.S. data on radioactivity in milk presented in *Radiological Health Data and*

XUM

Table 2. Concentrations of radionuclides in milk for July 1971 and 12-month period August 1970 through July 1971

Sampling location		Type of sample[a]	Radionuclide concentration (pCi/liter)					
			Strontium-90		Iodine-131		Cesium-137	
			Monthly average[b]	12-month average	Monthly average[b]	12-month average	Monthly average[b]	12-month average
UNITED STATES:								
Ala:	Montgomery[c]	P	6	7	0	0	13	10
Alaska:	Palmer[c]	P	6	5	0	0	16	12
Ariz:	Phoenix[c]	P	0	0	0	0	0	0
Ark:	Little Rock[c]	P	11	12	0	0	15	13
Calif:	Sacramento[c]	P	0	1	0	0	0	0
	San Francisco[c]	P	8	4	0	0	0	0
	Del Norte	P	12	15	0	0	0	11
	Fresno	P	2	2	0	0	0	1
	Humboldt	P	4	5	0	0	0	4
	Los Angeles	P	2	2	0	0	0	0
	Mendocino	P	6	6	0	0	0	4
	Sacramento	P	2	3	0	0	0	1
	San Diego	P	0	1	0	0	0	1
	Santa Clara	P	0	2	0	0	0	1
	Shasta	P	3	3	0	0	0	3
	Sonoma	P	3	3	0	0	0	3
Colo:	Denver[c]	P	4	4	0	0	17	6
	West	R	(d)		<0	<0	<0	<0
	Northeast	R	(d)		<0 (6)	<0	<0 (6)	<1
	East	R	(d)		NS	<0	NS	<0
	Southeast	R	(d)		NS	<0	NS	<0
	South Central	R	(d)		NS	NS	NS	NS
	Southwest	R	(d)		<0	<0	<0	<3
	Northwest	R	(d)		<0	<4	<0	<0
Conn:	Hartford[c]	P	9	7	0	0	16	11
	Central	P	7	6	0	0	20	16
Del:	Wilmington[c]	P	10	9	0	0	11	7
D.C:	Washington[c]	P	9	7	0	0	14	10
Fla:	Tampa[c]	P	5	5	0	0	37	45
	Central	R	8	6	0	0	37	42
	North	R	5	8	0	0	33	26
	Northeast	R	7	7	0	0	48	34
	Southeast	R	7	7	0	1	70	72
	Tampa Bay area	P	6	6	0	0	41	46
	West	R	12	9	0	0	28	16
Ga:	Atlanta[c]	P	10	11	0	0	20	14
Hawaii:	Honolulu[c]	P	0	2	0	0	11	1
Idaho:	Idaho Falls[c]	P	6	5	0	0	0	6
Ill:	Chicago[c]	P	7	7	0	0	12	11
Ind:	Indianapolis[c]	P	7	7	0	0	0	7
	Northeast	P	8	9	0	0	25	15
	Southeast	P	12	10	0	0	20	15
	Central	P	8	8	0	5	15	12
	Southwest	P	8	10	0	0	35	13
	Northwest	P	8	10	0	0	20	13
Iowa:	Des Moines[c]	P	5	6	0	0	0	3
	Iowa City	P	9	8	0	0	21	15
	Des Moines	P	7	7	0 (3)	0	12 (3)	11
	Spencer	P	NS	NS	NS	NS	NS	NS
	Fredericksburg	P	NS	NS	NS	NS	NS	NS
Kans:	Wichita[c]	P	9	7	0	0	11	2
	Coffeyville	P	9	8	0	3	10	9
	Dodge City	P	7	8	0	0	15	3
	Falls City	P	5	11	0	5	20	9
	Hays	P	8	9	0	4	13	6
	Kansas City	P	8	9	0	3	7	12
	Topeka	P	8	8	0	1	6	11
	Wichita	P	11	11	0	2	18	8
Ky:	Louisville[c]	P	9	9	0	0	12	3
La:	New Orleans[c]	P	17	14	0	0	29	19
Maine:	Portland[c]	P	9	9	0	0	32	21
Md:	Baltimore[c]	P	10	8	0	0	20	7
Mass:	Boston[c]	P	11	9	0	0	14	18
Mich:	Detroit[c]	P	7	7	0	0	17	11
	Grand Rapids[c]	P	10	9	0	0	11	15
	Bay City	P	5	6	<0 (2)	<0	17 (2)	13
	Charlevoix	P	8	10	<0 (3)	<1	20 (3)	15
	Detroit	P	9	7	<0	<0	0	8
	Grand Rapids	P	7	8	<0	<0	0	8
	Lansing	P	8	8	<0	<0	23	15
	Marquette	P	7	10	<0 (2)	<0	31 (2)	22
	Monroe	P	3	5	<0 (2)	<0	6 (2)	3
	South Haven	R	6	7	<0 (4)	<0	15 (4)	8
Minn:	Minneapolis[c]	P	8	9	0	0	26	15
	Bemidji	P	9	8	0	0	19	21
	Duluth	P	13	18	0	0	43	27
	Fergus Falls	P	8	7	0	0	18	21
	Little Falls	P	18	15	0	0	50	30
	Mankato	P	9	6	0	0	13	11
	Minneapolis	P	14	11	0	0	19	17
	Rochester	P	9	8	0	0	15	18
	Worthington	P	NS	4	NS	0	NS	0

See footnotes at end of table.

Table 2. Concentration of radionuclides in milk for July 1971 and 12-month period August 1970 through July 1971—Continued

Sampling location		Type of sample[a]	Radionuclide concentration (pCi/liter)					
			Strontium-90		Iodine-131		Cesium-137	
			Monthly average[b]	12-month average	Monthly average[b]	12-month average	Monthly average[b]	12-month average
UNITED STATES—Continued								
Miss:	Jackson[c]	P	15	12	0	0	18	9
Mo:	Kansas City[c]	P	9	7	0	0	0	3
	St. Louis[c]	P	0	6	0	0	0	4
Mont:	Helena[c]	P	10	6	0	0	14	11
Nebr:	Omaha[c]	P	10	6	0	0	15	3
Nev:	Las Vegas[c]	P	3	2	0	0	16	1
N.H:	Manchester[c]	P	8	9	0	0	25	23
N.J:	Trenton[c]	P	9	9	0	0	17	11
N. Mex:	Albuquerque[c]	P	4	3	0	0	0	0
N.Y:	Buffalo[c]	P	8	7	0	0	12	11
	New York City[c]	P	9	9	0	0	16	17
	Syracuse[c]	P	7	7	0	0	14	10
	Albany	P	8	8	0 (4)	0	<0 (4)	<0
	Buffalo	P	<0	<0	0	0	<0	<0
	Massena	P	NS		NS		NS	
	Newburg	P	5	7	0 (2)	0	<0 (2)	<0
	New York City	P	11	10	0	0	<0	<0
	Syracuse	P	11	4	0	0	<0 (2)	<0
N.C:	Charlotte[c]	P	13	11	0	0	19	13
N. Dak:	Minot[c]	P	11	10	0	0	12	8
Ohio:	Cincinnati[c]	P	6	7	0	0	11	2
	Cleveland[c]	P	9	8	0	0	14	11
Okla:	Oklahoma City[c]	P	7	6	0	0	16	8
Oreg:	Portland[c]	P	6	5	5	0	0	4
	Baker	P	0	2	0	0	0	6
	Coos Bay	P	6	6	0	0	0	9
	Eugene	P	0	3	0	0	0	3
	Medford	P	0	1	0	0	0	7
	Portland composite	P	8	6	0	0	18	6
	Portland local	P	4	4	0	0	17	9
	Redmond	P	NA	3	0	0	0	2
	Tillamook	P	10	7	0	0	22	17
Pa:	Philadelphia[c]	P	10	8	0	0	18	8
	Pittsburgh[c]	P	12	11	0	0	18	14
	Dauphin	P	8	7	0	1	0	12
	Erie	P	NS	7	NS	0	NS	23
	Philadelphia	P	9	8	0	0	18	16
	Pittsburgh	P	10	11	0	1	17	19
R.I:	Providence[c]	P	11	8	0	0	23	19
S.C:	Charleston[c]	P	11	9	0	1	20	15
S. Dak:	Rapid City[c]	P	4	6	0	0	22	5
Tenn:	Chattanooga[c]	P	10	9	0	0	19	9
	Memphis[c]	P	6	7	0	0	12	9
	Chattanooga	P	11	8	0	0	0	15
	Clinton	R	10	9	0 (2)	0	23 (2)	17
	Knoxville	P	8	6	0	0	10	13
	Nashville	P	8	6	0	0	19	12
	Fayetteville	P	11	11	0	0	14	14
	Kingston	R	9	9	0 (2)	0	19 (2)	20
	Pulaski	R	9	9	0 (2)	0	0 (2)	0
Tex:	Austin[c]	P	0	1	0	0	0	0
	Dallas[c]	P	6	6	0	0	12	5
	Amarillo	R	NA		NA		NA	
	Corpus Christi	R	NA		NA		NA	
	El Paso	R	NA		NA		NA	
	Forth Worth	R	NA		NA		NA	
	Harlingen	R	NA		NA		NA	
	Houston	R	NA		NA		NA	
	Lubbock	R	NA		NA		NA	
	Midland	R	NA		NA		NA	
	San Antonio	R	NA		NA		NA	
	Texarkana	R	NA		NA		NA	
	Tyler	R	NA		NA		NA	
	Uvalde	R	NA		NA		NA	
	Wichita Falls	R	NA		NA		NA	
Utah:	Salt Lake City[c]	P	4	5	0	0	15	16
Vt:	Burlington[c]	P	7	6	0	0	15	15
Va:	Norfolk[c]	P	10	9	0	0	14	7
Wash:	Seattle[c]	P	6	5	0	0	20	4
	Spokane[c]	P	7	6	0	0	12	3
	Benton County	R	0	1	0	0	0	2
	Franklin County	R	NS	3	NS	0	NS	5
	Sandpoint, Idaho	R	18	12	0	0	31	23
	Skagit County	R	8	7	0	0	13	12
W. Va:	Charleston[c]	P	12	9	0	0	18	9
Wisc:	Milwaukee[c]	P	7	6	0	0	11	12
Wyo:	Laramie[c]	P	3	5	0	0	0	1
CANADA:								
Alberta:	Calgary	P	NA		NA		NS	
	Edmonton	P	NA		NA		35	23

See footnotes at end of table.

XUM

Table 3. Concentration of radionuclides in milk for July 1971 and 12-month period August 1970 through July 1971—Continued

Sampling location	Type of sample[a]	Radionuclide concentration (pCi/liter)					
		Strontium-90		Iodine-131		Cesium-137	
		Monthly average[b]	12-month average	Monthly average[b]	12-month average	Monthly average[b]	12-month average
CANADA:—Continued							
British Columbia: Vancouver	P	NA		NA		24	23
Manitoba: Winnipeg	P	NA		NA		19	24
New Brunswick: Fredericton	P	NA		NA		21	24
Newfoundland: St. John's	P	NA		NA		70	32
Nova Scotia: Halifax	P	NA		NA		30	22
Ontario: Ottawa	P	NA		NA		16	15
Sault Ste. Marie	P	NA		NA		39	33
Thunder Bay	P	NA		NA		53	28
Toronto	P	NA		NA		12	13
Windsor	P	NA		NA		24	23
Quebec: Montreal	P	NA		NA		20	19
Quebec	P	NA		NA		38	29
Saskatchewan: Regina	P	NA		NA		26	14
Saskatoon	P	NA		NA		26	19
CENTRAL AND SOUTH AMERICA:							
Colombia: Bogota	P	2	1	0	0	0	0
Chile: Santiago	P	0	0	0	0	13	1
Ecuador: Guayaquil	P	0	0	0	0	0	0
Jamaica: Mandeville	P	3	4	0	0	49	48
Venezuela: Caracas	P	0	0	0	0	0	0
Canal Zone: Cristobal[c]	P	0	1	0	0	0	9
Puerto Rico: San Juan[c]	P	2	3	0	0	19	12
PMN network average[f]		7	7	0	0	13	9

[a] P, pasteurized milk.
R, raw milk.

[b] When an individual sampling result was equal to or less than the practical reporting level, a value of "0" was used for averaging. Monthly averages less than the practical reporting level reflect the fact that some but not all of the individual samples making up the average contained levels greater than the practical reporting level. When more than one analysis was made in a monthly period, the number of samples in the monthly average is given in parentheses.

[c] Pasteurized Milk Network station. All other sampling locations are part of the State or National network.

[d] Radionuclide analysis not routinely performed.

[e] The practical reporting levels for these networks differ from the general ones given in the text. Sampling results for the networks were equal to or less than the following practical reporting levels:

Iodine-131: Colorado—25 pCi/liter; Michigan—14 pCi/liter; Oregon—15 pCi/liter
Cesium-137: Colorado—25 pCi/liter; New York—20 pCi/liter; Oregon—15 pCi/liter
Strontium-90: New York—3 pCi/liter

[f] This entry gives the average radionuclides concentrations for the Pasteurized Milk Network stations denoted by footnote [e].

NA, no analysis.
NS, no sample collected.

Reports in perspective, a summary of the guidance provided by the Federal Radiation Council for specific environmental conditions was presented in the December 1970 issue of *Radiological Health Data and Reports.*

Data reporting format

Table 2 presents the integrated results of the international, national, and State networks discussed earlier. Column 1 lists all the stations which are routinely reported to *Radiological Health Data and Reports.* The relationship between the PMN stations and the State stations is shown in figure 2. The first column under each of the reported radionuclides gives the monthly average for the station and the number of samples analyzed in that month in parentheses. When an individual sampling result is equal to or below the practical reporting level for the radionuclide, a value of zero is used for averaging. Monthly averages are calculated using the above convention. Averages which are equal to or less than the practical reporting levels reflect the presence of radioactivity in some of the individual samples greater than the practical reporting level.

The second column under each of the radionuclides reported gives the 12-month average for the station as calculated from the preceding 12 monthly average, giving each monthly average equal weight. Since the daily intake of radioactivity by exposed population groups, averaged over a year, constitutes an appropriate criterion for the case where the FRC radiation protection guides apply, the 12-month average serves as a basis for comparison.

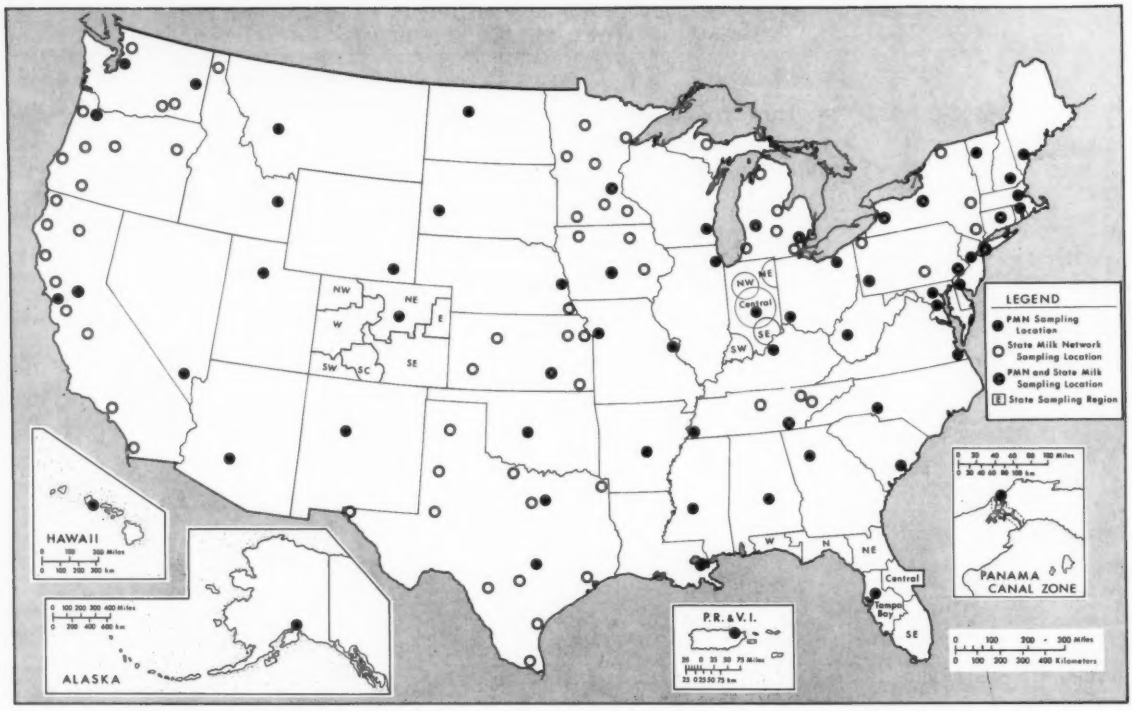

Figure 2. State and PMN milk sampling locations in the United States

Discussion of current data

In table 2, surveillance results are given for strontium-90, iodine-131, and cesium-137 for July 1971 and the 12-month period, August 1970 to July 1971. Except where noted, the monthly average represents a single sample for the sampling station. Strontium-89 and barium-140 data have been omitted from table 2 since levels at the great majority of the stations for July 1971 were below the respective practical reporting levels. Table 3 gives monthly average for those stations at which strontium-89 was detected.

Iodine-131 results are included in the table, even though they were generally below practical reporting levels. Because of the lower guide levels established by the Federal Radiation Council, levels in milk for this radionuclide are of particular public health interest. In general, the practical reporting level for iodine-131 is nu-

Table 3. Strontium-89 in milk, July 1971

Sampling location		Radionuclide concentration (pCi/liter)
Calif:	Del Norte (State)	7
	Humboldt (State)	6
	Mendocino (State)	5
	San Francisco (PMN)	7
	Sonoma (State)	5
Colo:	Denver (PMN)	10
Idaho:	Idaho Falls (PMN)	6
Iowa:	Des Moines (PMN)	8
Kans:	Dodge City (State)	5
	Falls City (State)	11
	Hays (State)	8
	Topeka (State)	6
Ky:	Louisville (PMN)	6
Minn:	Minneapolis (PMN)	14
Mont:	Helena (PMN)	12
Nebr:	Omaha (PMN)	6
N.Dak:	Minot (PMN)	13
Ohio:	Cincinnati (PMN)	8
Okla:	Oklahoma City (PMN)	8
Oreg:	Portland (PMN)	6
Pa:	Philadelphia (PMN)	6
	Pittsburgh (PMN)	7
S.Dak:	Rapid City (PMN)	7
Tenn:	Clinton (State)	8
	Nashville (State)	6
Utah:	Salt Lake City (PMN)	8
Wash:	Spokane (PMN)	10
Colombia:	Bogota (PAHO)	6
Chile:	Santiago (PAHO)	[a]126
Ecuador:	Guayaquil (PAHO)	6

[a] Attributed to French nuclear tests conducted in the Pacific.

merically equal to the upper value of Range I (10 pCi/liter) of the FRC radiation protection guide.

Strontium-90 monthly averages ranged from 0 to 18 pCi/liter in the United States for July 1971, and the highest 12-month average was 18 pCi/liter (Duluth, Minn.) representing 9.0 percent of the Federal Radiation Council radiation protection guide. Cesium-137 monthly averages ranged from 0 to 70 pCi/liter in the United States for July 1971, and the highest 12-month average was 72 pCi/liter (Southeast Florida), representing 2.0 percent of the value derived from the recommendations given in the Federal Radiation Council report. Of particular interest are the consistently higher cesium-137 levels that have been observed in Florida (*8*) and Jamaica.

Acknowledgement

Appreciation is expressed to the personnel of the following agencies who provide data for their milk surveillance networks:

Bureau of Radiological Health
Division of Environmental Sanitation
California State Department of Health

Radiation Protection Division
Canadian Department of National Health and Welfare

Radiological Health Section
Division of Occupational and Radiological Health
Colorado Department of Health

Radiological Health Services
Division of Medical Services
Connecticut State Department of Health

Radiological and Occupational Health Section
Department of Health and Rehabilitative Services
State of Florida

Bureau of Environmental Sanitation
Division of Sanitary Engineering
Indiana State Board of Health

Division of Radiological Health
Environmental Engineering Services
Iowa State Department of Health

Radiation Control Section
Environmental Health Division
Kansas State Department of Health

Radiological Health Services
Division of Occupational Health
Michigan Department of Health

Radiation Control Section
Division of Environmental Health
State of Minnesota Department of Health

Bureau of Radiological Pollution Control
New York State Department of Environmental Conservation

Environmental Radiation Surveillance Program
Division of Sanitation and Engineering
Oregon State Board of Health

Radiological Health Section
Bureau of Environmental Health
Pennsylvania Department of Public Health

Radiological Health Services
Division of Preventable Diseases
Tennessee Department of Public Health

Division of Occupational Health
Environmental Health Services
Texas State Department of Health

Radiation Control Section
Division of Health
Washington Department of Social and Health Services

REFERENCES

(1) CAMPBELL, J. E., G. K. MURTHY, A. S. GOLDIN, H. B. ROBINSON, C. P. STRAUB, F. J. WEBER and K. H. LEWIS. The occurrence of strontium-90, iodine-131, and other radionuclides in milk, May 1957 through April 1958. Amer J Pub Health 49:225 (February 1959).
(2) U.S. ATOMIC ENERGY COMMISSION, DIVISION OF ISOTOPES DEVELOPMENT. Chart of the Nuclides, Tenth Edition revised to December 1968. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (1970).
(3) NATIONAL CENTER FOR RADIOLOGICAL HEALTH. Section I. Milk Surveillance. Radiol Health Data Rep 9:730–746 (December 1968).
(4) ROSENSTEIN, M. and A. S. GOLDIN. Statistical technics for quality control of environmental radioassay. Health Lab Sci 2:93 (April 1965).
(5) KNOWLES, F. Interlaboratory study of iodine-131, cesium-137, barium-140, strontium-89, and strontium-90 measurements in milk, May–July 1970, Technical experiment 70-MKAQ-1. Analytical Quality Control Service, Bureau of Radiological Health (September 1970).
(6) NEILL, R. H. and D. R. SNAVELY. State Health Department sampling criteria for surveillance of radioactivity in milk. Radiol Health Data Rep 8:621–627 (November 1967).
(7) ROBINSON, P. B. A comparison of results between the Public Health Service Raw Milk and Pasteurized Milk Networks for January 1964 through June 1966. Radiol Health Data Rep 9:475–488 (September 1968).
(8) PORTER, C. R., C. R. PHILLIPS, M. W. CARTER, and B. KAHN. The cause of relatively high cesium-137 concentrations in Tampa, Florida, milk. Radioecological Concentration Processes, Proceedings of an International Symposium held in Stokholm, April 25–29, 1966. Pergamon Press, New York, N.Y. (1966) pp. 95–101.

Food and Diet Surveillance

Efforts are being made by various Federal and State agencies to estimate the dietary intake of selected radionuclides on a continuing basis. These estimates, along with the guidance developed by the Federal Radiation Council, provide a basis for evaluating the significance of radioactivity in foods and diet.

Networks presently in operation and reported routinely include those listed below. These networks provide data useful for developing estimates of nationwide dietary intakes of radionuclides. Programs reported in *Radiological Health Data and Reports* are as follows:

Program	Period reported	Issue
California Diet Study	July–December 1970	November 1971
Carbon-14 in Total Diet and Milk	July–December 1970	May 1971
Connecticut Standard Diet	July–December 1969	December 1970
Radionuclides in Institutional Diet Samples	April–June 1971	November 1971
Strontium-90 in Tri-City Diets	January–December 1969	June 1970

Radionuclides in Institutional Diet Samples, April-June 1971

Environmental Protection Agency and
Food and Drug Administration

The determination of radionuclide concentrations in the diet constitutes an important element of an integrated program of environmental radiological surveillance and assessment. Recognizing that the diet is a potentially significant contributor to total environmental radiation exposures, the Public Health Service initiated its Institutional Diet Sampling Program in 1961. The program is now administered by the Office of Radiation Programs, Environmental Protection Agency with the assistance of the Bureau of Compliance, Food and Drug Administration, Department of Health, Education and Welfare (*1*).

This program estimates the dietary intake of radionuclides in a selected population group, ranging from children to young adults of school age. At present, 25 institutions, distributed geographically as shown in figure 1, are being sampled. Previous results showed that the daily dietary intake of teenage girls and children from 9 to 12 years of age were comparable, but teenage boys consumed 20 percent more food per day (*1–2*). Extrapolating this information, estimates for teenage boys and/or girls can be calculated on the basis of the dietary intake of children.

The sampling procedure is generally the same at each institution. Each sample represents the edible portion of the diet for a full 7-day week, (21 meals plus between-meal snacks) obtained by duplicating the food intake of a different individual daily. Drinking water, which is not included, is also sampled periodically. Each daily sample is kept frozen until the end of the collection period. It is then packed in dry ice and shipped by air to either the Western Environmental Research Laboratory, Las Vegas, Nev; the Eastern Environmental Radiation Laboratory, Mont-

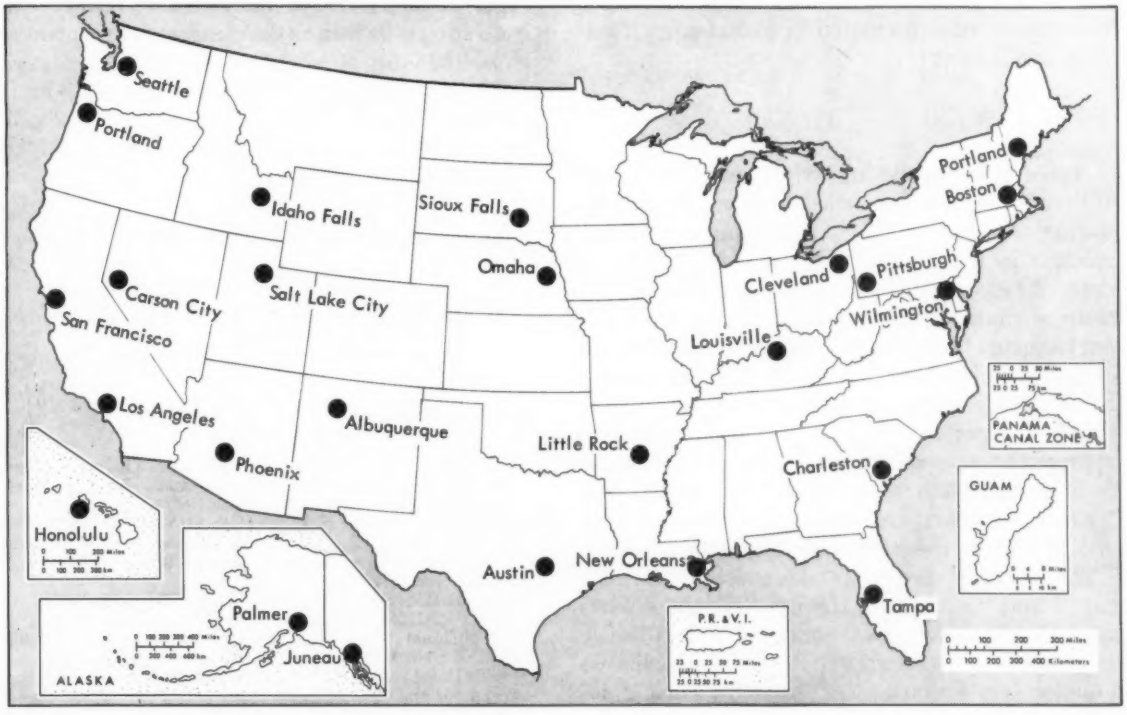

Figure 1. Institutional diet sampling locations as of June 1971

Table 1. Concentration and intake of stable elements and radionuclides in institutional total diets of children April–June 1971

Location of Institution		Month[a] (1971)	Total weight (kg/day)	Calcium		Potassium		^{90}Sr		^{137}Cs	
				(g/kg)	(g/day)	(g/kg)	(g/day)	(pCi/kg)	(pCi/day)	(pCi/kg)	(pCi/day)
Alaska:	Juneau	April	1.13	0.6	0.7	1.4	1.6	3	3	0	0
	Palmer	April	1.03	.2	.2	1.2	1.2	5	5	13	13
Ariz:	Phoenix	April	1.67	.4	.8	1.6	2.7	0	0	0	0
Ark:	Little Rock	April	1.42	.7	1.0	1.6	2.2	8	11	15	21
Calif:	Los Angeles	April[b]	1.34	.4	.5	1.4	1.8	0	0	0	0
	San Francisco	April[b]	2.00	.6	1.3	1.4	2.8	0	0	0	0
Del:	Wilmington	April	2.14	.6	1.4	1.6	3.5	7	14	11	24
Fla:	Tampa	April	2.47	.5	1.4	1.4	3.5	6	14	23	57
Hawaii:	Honolulu	April	2.17	.5	1.1	1.4	3.0	2	5	12	26
Idaho:	Idaho Falls	April[b]	2.09	.8	1.6	1.5	3.1	12	26	11	23
Ky:	Louisville	April	2.80	.6	1.7	1.6	4.5	6	17	13	36
La:	New Orleans	April[b]	1.48	.6	.9	1.5	2.2	8	12	15	22
Maine:	Portland	April	1.76	.9	1.6	1.6	2.9	17	31	18	32
Mass:	Boston	April	1.97	.7	1.4	1.7	3.4	8	16	14	28
Nebr:	Omaha	April[b]	2.34	1.0	2.2	1.6	3.7	10	24	0	0
Nev:	Carson City	April	1.26	.8	1.0	1.3	1.7	3	4	0	0
N. Mex:	Albuquerque	April	1.06	.9	1.0	1.5	1.6	0	0	0	0
Ohio:	Cleveland	April[b]	1.55	.8	1.3	1.9	3.0	14	21	14	22
Oreg:	Portland	April[b]	1.97	.6	1.2	1.8	3.5	3	7	13	26
Pa:	Pittsburgh	April[b]	2.50	.6	1.5	1.3	3.3	9	22	15	38
S.C:	Charleston	April	2.76	.7	2.0	1.5	4.3	6	16	18	50
S. Dak:	Sioux Falls	April[b]	.94	.8	.7	1.5	1.4	14	13	0	0
Tex:	Austin	April[b]	1.68	.7	1.1	1.5	2.5	4	6	0	0
Utah:	Salt Lake City	April	2.08	.5	1.1	1.0	2.1	0	0	0	0
Wash:	Seattle	April[b]	2.13	.6	1.4	1.4	3.1	0	0	0	0
Institutional average			1.83	.7	1.2	1.5	2.7	6	11	8	17

[a] Quarterly sample usually collected the first month of the quarter.
[b] Food samples were collected from two or more children who were not between the ages of 9 and 12. Note: Strontium-89, iodine-131, and barium-140 were not detected at any station during this period.

gomery, Ala; or the Northeastern Radiological Health Laboratory, Winchester, Mass. A detailed description of sampling and analytical procedures has already been presented in *Radiological Health Data and Reports* (*3*).

Results

Table 1 shows the analytical results for institutional diet samples collected from all stations during April–June 1971. The stable elements calcium and potassium are reported in g/kg of diet. Where applicable, radionuclide concentrations of these samples reported in pCi/kg of diet are corrected for radioactive decay to the midpoint of the sample collection period. Dietary intakes in g/day or pCi/day were obtained by multiplying the food consumption rate in kg/day by the appropriate concentration values. The average food consumption rate during this period was 1.83 kg/day compared to the network average of 1.86 kg/day observed from 1961 through 1970.

Strontium-90 dietary intake averaged 11 pCi/day during this period. Cesium-137 intake averaged 17 pCi/day. These results fall within Range I as defined by the former Federal Radiation Council (*4*). Strontium-89, barium-140, and iodine-131 concentrations were below detectable levels.

All concentrations less than or equal to the appropriate minimum detectable level have been reported as zero. The minimum detectable concentration is defined as the measured concentration equal to the 2 standard-deviation analytical error. Accordingly, the minimum detectable limits are strontium-89, 5 pCi/kg; strontium-90, 2 pCi/kg; iodine-131, 10 pCi/kg; barium-140, 10 pCi/kg; cesium-137, 10 pCi/kg.

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
April–June 1970	January 1971
July–September 1970	February 1971
October–December 1970	May 1971
January–March 1971	September 1971

REFERENCES

(*1*) ANDERSON, E. C., D. J. NELSON, JR. Surveillance for radiological contamination in foods. Amer J Public Health 52:1391–1400 (September 1962).

(*2*) PUBLIC HEALTH SERVICE, DIVISION OF RADIOLOGICAL HEALTH. Radionuclides in institutional total diet samples, January–March 1965. Radiol Health Data 6:548–554 (October 1965).

(*3*) PUBLIC HEALTH SERVICE, NATIONAL CENTER FOR RADIOLOGICAL HEALTH. Radionuclides in institutional total diet samples, January–March 1968. Radiol Health Data Rep 9:557–560 (October 1968).

(*4*) FEDERAL RADIATION COUNCIL. Background material for the development of radiation protection standards, Report No. 2. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (September 1961).

XUM

Estimated Daily Intake of Radionuclides in California Diets July-December 1970

Bureau of Radiological Health
California State Department of Public Health

Since January 1964, the Bureau of Radiological Health, California State Department of Public Health, has made estimates of radionuclide levels in the diets of Californians (*1*).

Recognizing that a "standard" or "typical" diet does not exist due to variations in individual tastes, an effort was made to select a diet which was reasonably representative of the food consumed in a given area. This objective was met by utilizing the "house" diet of a hospital in each of the 19 geographic areas of interest (figure 1).

Hospitals were chosen as the source of diet samples under the hypothesis that their diets are as "reasonably representative" as any other. General hospitals exist in each of the 19 selected geographic areas and operate with trained dietitians. There is good reason to believe that hospitals utilize foods which are marketed in their respective communities. Also, working relations for entry into hospitals existed through the State Bureau of Nutrition and Hospitals.

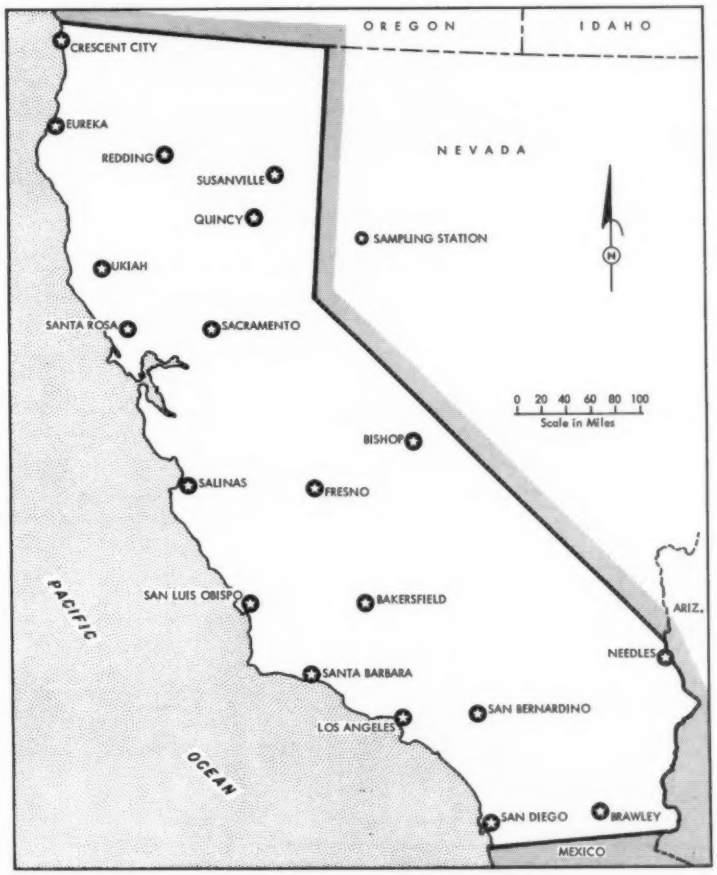

Figure 1. California diet sampling stations

Table 1. Estimated daily intakes of radionuclides in California diets,[a] July–September 1970

City	Consumption (kg/capita-day)[b]	Intake (pCi/capita-day)							Intake (g/capita-day)		
		^{89}Sr	^{90}Sr	^{226}Ra	^{137}Cs	^{95}Zr	^{54}Mn	$^{141-144}Ce$	K[c]	Na	Ca
Bakersfield	1.7	1	5	1.1	0	4	15	0	2.5	3.8	0.7
Bishop	1.9	0	6	1.5	2	2	13	2	2.8	2.7	.8
Brawley	2.2	7	9	1.9	0	8	13	0	3.1	4.3	1.3
Crescent City	2.0	6	12	1.5	10	1	16	0	2.9	4.1	.8
Eureka	2.2	3	6	.8	0	5	17	0	2.6	3.9	.7
Fresno	2.1	0	6	1.3	0	5	20	7	3.4	3.1	1.1
Los Angeles	2.3	0	6	1.0	2	4	17	0	3.2	4.0	.8
Needles	2.3	0	8	.4	0	8	13	0	2.9	3.3	1.1
Quincy	2.6	0	7	.8	0	4	14	0	4.3	4.4	1.2
Redding	2.5	4	7	1.1	2	4	17	0	4.1	3.4	1.1
Sacramento	2.7	4	4	1.3	0	6	27	0	3.1	4.4	1.2
Salinas	2.5	0	6	1.0	0	7	15	0	3.4	6.9	.8
San Bernardino	2.0	0	4	.7	0	4	18	0	3.2	3.8	1.0
San Diego	1.8	0	6	1.0	0	3	14	0	2.8	3.0	.8
San Luis Obispo	2.3	1	6	1.6	2	3	20	0	3.5	4.6	1.2
Santa Barbara	2.3	0	7	1.4	1	5	15	0	3.2	2.9	1.3
Santa Rosa	1.8	5	2	1.4	0	3	13	6	2.4	3.7	.9
Susanville	1.8	1	6	.7	5	4	13	7	2.4	2.5	.8
Ukiah	2.0	0	7	.4	0	5	15	7	3.1	3.6	1.3

[a] Based on analyses of Hospital Standard Diets located in listed cities.
[b] Kilograms of food per person per day in this diet.
[c] Natural potassium contains 0.0119 percent of radioactive potassium-40.

Sampling procedure

In general, the sampling procedure is the same at each hospital. Samples are collected every 2 months at each facility. Each sample represents the edible portion of a regular meal (the standard diet) for a full 7-day week (21 consecutive meals.)

After each sample is collected, it is suitably preserved and shipped to the Sanitation and Radiation Laboratory of the State Department of Public Health. Accompanying each sample is a record prepared by the dietitians indicating the types and quantities of food included.

Analytical procedures

After weighing at the laboratory, each sample is homogenized and analyzed for gamma-ray emitters, then dried and ashed prior to analysis for strontium-89, strontium-90, radium-226, and stable calcium, strontium, and sodium.

Data and discussion

The resultant estimates of daily intake of radionuclides in the California diets are given in table 1 (July–September 1970) and table 2 (October–December 1970).

Table 2. Estimated daily intakes of radionuclides in California diets,[a] October–December 1970

City	Consumption (kg/capita-day)[b]	Intake (pCi/capita-day)							Intake (g/capita-day)		
		^{89}Sr	^{90}Sr	^{226}Ra	^{137}Cs	^{95}Zr	^{54}Mn	$^{141-144}Ce$	K[c]	Na	Ca
Bakersfield	1.9	0	8	1.1	2	3	15	0	3.0	4.6	1.1
Bishop	1.7	0	4	1.1	0	6	12	0	2.4	2.9	.7
Brawley	1.6	4	11	1.8	0	3	12	10	2.9	4.2	.7
Crescent City	2.1	0	12	1.1	1	6	16	0	3.0	4.2	.8
Eureka	2.1	0	6	1.1	1	5	14	14	2.6	3.9	.6
Fresno	2.2	0	7	.9	0	4	18	0	3.3	3.3	1.0
Los Angeles	2.0	1	5	1.5	2	4	16	0	3.0	4.0	.6
Needles	2.2	2	4	1.2	4	4	16	0	2.4	3.0	.8
Quincy	2.3	3	5	1.2	1	2	18	16	3.0	3.0	.7
Redding	2.4	1	8	1.7	2	7	17	0	3.3	3.5	1.4
Sacramento	2.6	3	6	2.0	0	8	16	0	3.5	4.5	1.2
Salinas	2.4	5	5	2.1	3	6	16	0	3.5	6.8	.9
San Bernardino	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
San Diego	2.2	2	6	1.2	5	6	16	0	3.3	3.3	1.0
San Luis Obispo	2.2	0	4	1.2	0	9	17	0	3.3	4.0	1.0
Santa Barbara	2.8	0	5	1.2	4	8	15	0	2.8	3.8	1.1
Santa Rosa	1.9	3	7	2.2	7	3	14	0	3.5	4.4	1.3
Susanville	1.7	2	4	.4	3	3	10	0	2.1	2.6	.8
Ukiah	2.1	4	6	1.2	0	4	16	0	3.1	4.0	1.4

[a] Based on analyses of Hospital Standard Diets located in listed cities.
[b] Kilograms of food per person per day in this diet.
[c] Natural potassium contains 0.0119 percent of radioactive potassium-40.
NS, no sample.

XUM

It should be noted that levels of radioactivity were observed to be far below those levels for which consideration should be given to protective health action.

A summary of strontium-90 and cesium-137 intake trends in California diets from January 1964 through December 1970 is given in figures 2 and 3.

REFERENCES

(1) STATE OF CALIFORNIA DEPARTMENT OF PUBLIC HEALTH, BUREAU OF RADIOLOGICAL HEALTH. Radiol Health News 4:4 (October 1965). 2151 Berkeley Way, Berkeley, Calif. 94704.

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
April–December 1969 and January–June 1970	November 1970

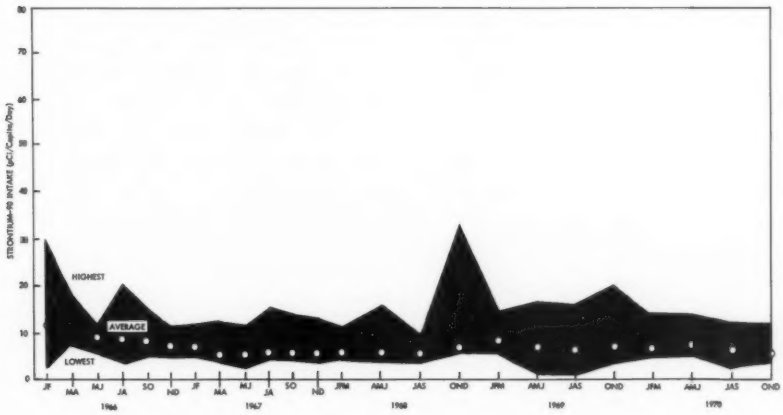

Figure 2. Averages and ranges of daily strontium-90 intake in California diets

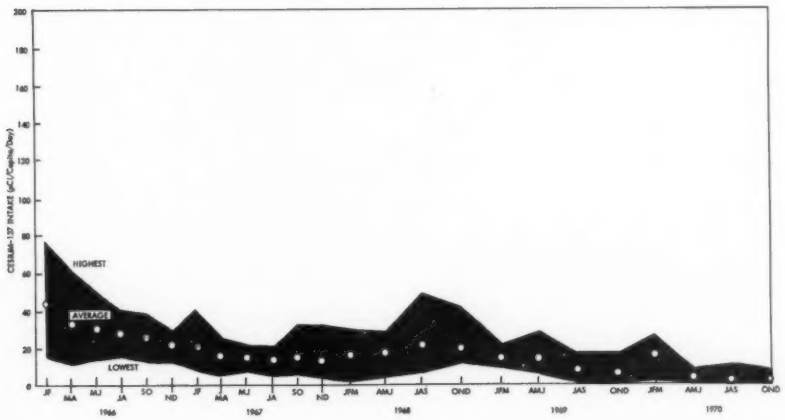

Figure 3. Averages and ranges of daily cesium-137 intake in California diets

Strontium-90 in Tri-City Diets, January-December 1970

Health and Safety Laboratory
U.S. Atomic Energy Commission

Estimates of the average intake of strontium-90 by New York City, Chicago, and San Francisco residents have been made by the Health and Safety Laboratory (*HASL*). These estimates were made by using measurements of the strontium-90 content of a large variety of foods purchased at the cities every 3 months and statistics on the average consumption of each food compiled by the U.S. Department of Agriculture in their 1955 Household Diet Survey (*1*). A detailed description of the aims and methods of the *HASL* diet sampling program along with a summary of the results obtained during the first 3 years of operation (1960–1963) was published earlier (*2*).

In 1968, two changes were made in the program. The first change was the suspension of the collection and analysis of foods purchased in Chicago. Previous experience had shown the levels of strontium-90 in the Chicago diet to be consistently between those of New York City and San Francisco. Thus, reasonable estimates of the dietary intake of strontium-90 in Chicago at any time can be made from the analyses of foods purchased in New York City and San Francisco.

The second change, revision of the estimates of the annual consumption of different diet components, was made because new information became available. This new information on the composition of the diet appeared in a preliminary report of the U.S. Department of Agriculture in their 1965 Household Diet Survey (*3*). The changes in the composition of the diet from 1955 to 1965 are not very great, and the estimates of strontium-90 intake made using statistics from

[1] Data from Fallout Program Quarterly Summary Report, HASL 227, 237, 239, 242. Available from the Clearinghouse for Federal Scientific and Technical Information, CFSTI, 5285 Port Royal Road, Springfield, Va. 22151.

Table 1. Average dietary consumption and strontium-90 intake in Tri-City diet, January–March 1970

Food category	Diet (kg/a)	Calcium (g/a)	New York City February 1970		San Francisco March 1970	
			Strontium-90		Strontium-90	
			(pCi/kg)	(pCi/a)	(pCi/kg)	(pCi/a)
Dairy products	200	216.0	7.5	1,500	2.5	504
Fresh fruit	59	9.4	7.8	462	1.7	103
Fresh vegetables	48	18.7	10.1	486	3.9	186
Root vegetables	10	3.8	.3	3	4.3	43
Potatoes	38	3.8	10.3	391	1.3	50
Macaroni	3	.6	4.9	15	3.6	11
Rice	3	1.1	2.4	7	1.8	5
Fruit juices	28	2.5	3.1	88	1.9	54
Canned vegetables	22	4.4	10.9	240	1.5	32
Canned fruit	11	.6	1.3	14	1.0	11
Dried beans	3	2.1	50.5	151	21.8	66
Flour	34	6.5	8.7	296	4.1	140
Bakery products	44	53.7	4.5	198	3.2	139
Whole grain products	11	10.3	13.6	150	5.5	61
Fresh fish	8	7.6	.2	2	.2	1
Shellfish	1	1.6	.8	1	.6	1
Poultry	20	6.0	1.6	33	1.6	32
Meat	79	12.6	1.2	98	.4	30
Eggs	15	8.7	1.8	26	2.0	29
Annual intake (pCi/a)		370		4,161		1,498
Daily intake (pCi/g Ca)				11.2		4.0

XUM

Table 2. Average dietary consumption and strontium-90 intake in Tri-City diet, April–June 1970

Food category	Diet (kg/a)	Calcium (g/a)	New York City May 1970		San Francisco June 1970	
			Strontium-90		Strontium-90	
			(pCi/kg)	(pCi/a)	(pCi/kg)	(pCi/a)
Dairy products	200	216.0	10.5	2,110	2.0	406
Fresh fruit	59	9.4	12.5	736	1.8	107
Fresh vegetables	48	18.7	11.8	568	3.1	146
Root vegetables	10	3.8	8.6	86	4.2	42
Potatoes	38	3.8	8.7	331	1.3	49
Macaroni	3	.6	4.4	13	4.4	13
Rice	3	1.1	1.6	5	2.3	7
Fruit juices	28	2.5	3.4	96	2.1	60
Canned vegetables	22	4.4	6.4	140	2.6	57
Canned fruit	11	.6	1.4	15	1.1	13
Dried beans	3	2.1	3.9	12	15.7	47
Flour	34	6.5	7.1	242	4.0	136
Bakery products	44	53.7	4.9	217	4.3	189
Whole grain products	11	10.3	11.6	128	8.6	94
Fresh fish	8	7.6	.6	5	1.6	13
Shellfish	1	1.6	1.4	1	.6	1
Poultry	20	6.0	1.9	38	.7	15
Meat	79	12.6	1.1	84	.6	49
Eggs	15	8.7	2.3	34	2.1	31
Annual intake (pCi/a)		370		4,861		1,475
Daily intake (pCi/g Ca)				13.1		4.0

either diet survey are not too different. Estimates of the intakes of other nuclides, however, may be affected to a greater degree. The new estimates of the consumption have therefore been used to calculate the intakes of calcium and strontium-90 for 1970 in New York City and San Francisco.

Results for January-December 1970 are presented in tables 1 through 4. The variation with time of the daily intake of strontium-90 in the three cities is plotted in figure 1.

Table 3. Average dietary consumption and strontium-90 intake in Tri-City diet, July–September 1970

Food category	Diet (kg/a)	Calcium (g/a)	New York City August 1970		San Francisco September 1970	
			Strontium-90		Strontium-90	
			(pCi/kg)	(pCi/a)	(pCi/kg)	(pCi/a)
Dairy products	200	216.0	9.0	1,810	2.1	420
Fresh fruit	59	9.4	2.2	128	3.1	185
Fresh vegetables	48	18.7	10.2	491	2.1	102
Root vegetables	10	3.8	4.3	43	4.4	44
Potatoes	38	3.8	4.5	172	3.1	118
Macaroni	3	.6	4.7	14	3.7	11
Rice	3	1.1	2.0	6	2.1	6
Fruit juices	28	2.5	3.6	102	1.8	49
Canned vegetables	22	4.4	12.7	279	2.0	44
Canned fruit	11	.6	1.4	15	.8	9
Dried beans	3	2.1	16.2	49	47.1	141
Flour	34	6.5	6.6	223	4.4	151
Bakery products	44	53.7	6.2	274	4.3	190
Whole grain products	11	10.3	15.1	166	7.1	78
Fresh fish	8	7.6	.3	2	.2	2
Shellfish	1	1.6	[a]1.4	[a]1	.6	1
Poultry	20	6.0	.8	15	1.8	35
Meat	79	12.6	[a]1.1	[a]84	.3	23
Eggs	15	8.7	2.3	35	1.4	22
Annual intake (pCi/a)		370		3,909		1,631
Daily intake (pCi/g Ca)				10.6		4.4

[a] The meat and shellfish samples for New York City were lost during analyses. Values reported for second quarter 1970 were used.

Table 4. Average dietary consumption and strontium-90 intake in Tri-City diet, October–December 1970

Food category	Diet (kg/a)	Calcium (g/a)	New York City November 1970		San Francisco December 1970	
			Strontium-90		Strontium-90	
			(pCi/kg)	(pCi/a)	(pCi/kg)	(pCi/a)
Dairy products	200	216.0	7.8	1,550	2.0	396
Fresh fruit	59	9.4	13.9	818	2.5	148
Fresh vegetables	48	18.7	16.9	812	3.5	168
Root vegetables	10	3.8	6.8	68	9.9	99
Potatoes	38	3.8	6.8	261	2.4	92
Macaroni	3	.6	5.2	16	4.1	12
Rice	3	1.1	1.8	6	1.5	4
Fruit juices	28	2.5	4.5	126	2.5	71
Canned vegetables	22	4.4	9.4	208	2.3	51
Canned fruit	11	.6	1.6	17	.8	8
Dried beans	3	2.1	19.6	59	7.5	22
Flour	34	6.5	8.2	280	4.4	150
Bakery products	44	53.7	6.6	290	3.4	152
Whole grain products	11	10.3	13.8	152	10.9	120
Fresh fish	8	7.6	.5	4	.4	4
Shellfish	1	1.6	.7	<1	.6	<1
Poultry	20	6.0	1.0	19	1.1	22
Meat	79	12.6	.7	55	.4	30
Eggs	15	8.7	2.0	30	1.5	23
Annual intake (pCi/a)		370		4,772		1,573
Daily intake (pCi/g Ca)				12.9		4.3

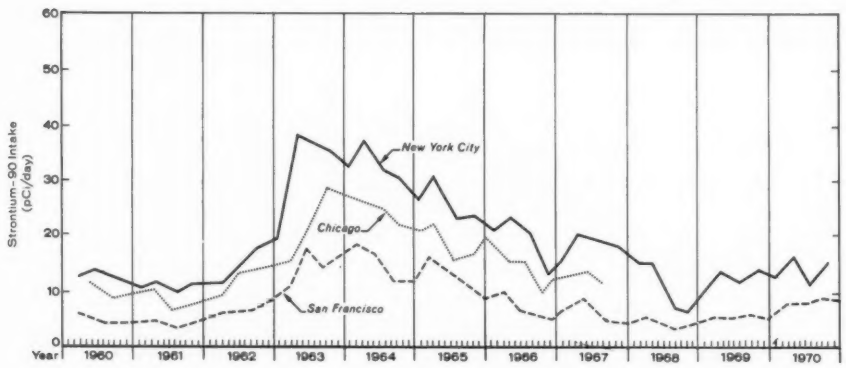

Figure 1. Daily intake of strontium-90 in Tri-City diets, March 1960–December 1970

REFERENCES

(*1*) U.S. DEPARTMENT OF AGRICULTURE. Food consumption of households in the United States, household food consumption survey, Report No. 1 (1955). Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (December 1956).

(*2*) RIVERA, J. and J. H. Harley. HASL contributions to the study of fallout in food chains, HASL-137. Office of Technical Services, U.S. Atomic Energy Commission, New York, N.Y. (July 1, 1964).

(*3*) U.S. DEPARTMENT OF AGRICULTURE. Food consumption of households in the United States, spring 1965. A Preliminary Report, USDA, ARS 62-16 (August 1967).

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
July–December 1968	December 1969
January–December 1969	June 1970

XUM

SECTION II. WATER

The Environmental Protection Agency and other Federal, State, and local agencies operate extensive water quality sampling and analysis programs for surface, ground, and treated water. Most of these programs include determinations of gross beta and gross alpha radioactivity and specific radionuclides.

Although the determination of the total radionuclide intake from all sources is of primary importance, a measure of the public health importance of radioactivity levels in water can be obtained by comparison of the observed values with the Public Health Service Drinking Water Standards (*1*). These standards, based on consideration of Federal Radiation Council (FRC) recommendations (*2–4*) set the limits for approval of a drinking water supply containing radium-226 and strontium-90 at 3 pCi/liter and 10 pCi/liter, respectively. Higher concentrations may be acceptable if the total intake of radioactivity from all sources remains within the guides recommended by FRC for control action. In the known absence[1] of strontium-90 and alpha-particle emitters, the limit is 1,000 pCi/liter gross beta radioactivity, except when additional analysis indicates that concentrations of radionuclides are not likely to cause exposures greater than the limits indicated by the Radiation Protection Guides. Surveillance data from a number of Federal and State programs are published periodically to show current and long-range trends. Water sampling activities reported in *Radiological Health Data and Reports* are listed below.

[1] Absence is taken to mean a negligibly small fraction of the specific limits of 3 pCi/liter and 10 pCi/liter for unidentified alpha-particle emitters and strontium-90, respectively.

Water sampling program	Period reported	Issue
California	January–December 1969	October 1971
Gross Radioactivity in Surface Waters of the United States	February 1971	October 1971
Interstate Carrier Drinking Water	1970	July 1971
Kansas	January–December 1969	September 1970
Minnesota	January–June 1970	November 1971
North Carolina	January–December 1967	May 1969
New York	January–December 1969 and January–June 1970	September 1971
Radiostrontium in Tap Water, *HASL*	January–June 1970	April 1971
Tritium in Community Water Supplies	1969	December 1970
Tritium Surveillance System	April–June 1971	November 1971
Washington	July 1968–June 1969	February 1971

REFERENCES

(*1*) U.S. PUBLIC HEALTH SERVICE. Drinking water standards, revised 1962, PHS Publication No. 956. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (March 1963).

(*2*) FEDERAL RADIATION COUNCIL. Radiation Protection Guidance for Federal Agencies, Memorandum for the President, September 1961. Reprint from the Federal Register of September 26, 1961.

(*3*) FEDERAL RADIATION COUNCIL. Background material for the development of Radiation Protection Standards, Report No. 1. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (May 1960).

(*4*) FEDERAL RADIATION COUNCIL. Background material for the development of Radiation Protection Standards, Report No. 2. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (September 1961).

Gross Radioactivity in Surface Waters of the United States, March 1971

Office of Water Programs
Environmental Protection Agency

The monitoring of gross radioactivity in surface waters of the United States was initiated in 1957, as part of the Water Pollution Surveillance System (formerly the National Water Quality Network) of the U.S. Public Health Service. Currently, the program is operated by the Environmental Protection Agency, Office of Water Programs. Regional offices of the Environmental Protection Agency are responsible for the collection of samples and entering of the analytical findings into STORET, the Office of Water Programs' computerized data storage and retrieval system. Radioactivity analyses are performed in the centralized radioactivity laboratories of the Office of Water Programs (Cincinnati, Ohio).

The regular reporting of gross radioactivity data in *Radiological Health Data and Reports* was terminated with the publication of data for October 1968 (April 1969 issue). With the publication of data for January 1971, it is intended to reinitiate this activity as a monthly report series. The unpublished data for the time interval of November 1968 through December 1970 will be the subject of a future summary article.

Table 1 presents the gross alpha and beta results for samples collected from 24 rivers during March 1971. The analytical procedures used for determining gross alpha and gross beta radioactivity are described in the 13th Edition of "Standard Methods for the Examination of

Table 1. Gross radioactivity in U.S. surface waters, March 1971[a]

River and station	Number of grab samples	Gross alpha radioactivity (pCi/liter)		Gross beta radioactivity (pCi/liter)	
		Suspended solids	Dissolved solids	Suspended solids	Dissolved solids
Allegheny River:					
Pittsburgh, Pa	1	2	1	3	6
	1	<0.2	<0.2	1	7
Beaver River:					
New Brighton, Pa	1	< .2	1	1	10
Big Sandy River:					
Wayne County, Ky	1	< .2	< .2	1	6
Big Sioux River:					
Sioux Falls, S. Dak	1	< .2	2	3	40
Cheyenne River:					
Edgemont, S. Dak:	1	< .2	9	2	19
Clinch River:					
Kingston, Tenn	3	(< .2, < .2)	(< .2, < .2)	(1, 1)	(4, 9)
		< .2	< .2	1	6.7
Cuyahoga River:					
Cleveland, Ohio	1	1	2	3	11
Great Lakes, Lake Erie:					
Buffalo, N.Y	1	< .2	< .2	2	10
Great Miami River:					
Lost Bridge, Ohio	1	3	5	6	6
Elizabethtown, Ohio:					
American Material Bridge	1	2	2	8	8
Liberty Fairfield, Ohio	1	3	2	18	11
Sellars Road, Ohio	1	2	4	7	5
Eldean Mills, Ohio	1	3	2	2	9
Guyandotte River:					
Guyandotte, W. Va	1	< .2	< .2	1	7
Kanawha River:					
Mason County, W. Va	1	< .2	< .2	1	5
Winfield Dam, W. Va	1	1	< .2	2	4
Kentucky River:					
Dam No. 1, Ky	1	2	< .2	2	2

XUM

Table 1. Gross radioactivity in U.S. surface waters, March 1971[a]—continued

River and station	Number of grab samples	Gross alpha radioactivity (pCi/liter)		Gross beta radioactivity (pCi/liter)	
		Suspended solids	Dissolved solids	Suspended solids	Dissolved solids
Licking River:					
12th St. Bridge, Ky	1	3	< .2	<1	9
Little Miami:					
Cincinnati, Ohio	1	12	< .2	15	8
Maumee River:					
Toledo, Ohio	1	1	1	<1	14
Mississippi River:					
Burlington, Iowa	1	1	2	4	12
Missouri River:					
Yankton, S. Dak	1	< .2	4	<1	9
St. Joseph, Mo	1	3	4	20	21
St. Louis, Mo	1	13	1	34	11
Monongahela River:					
Pittsburgh, Pa	1	< .2	< .2	2	9
	1	< .2	< .2	<1	5
Muskingum River:					
Lock and Dam No. 2, W. Va	1	2	3	6	8
North Platte River:					
Henry, Nebr	1	<2	28	<1	45
Ohio River:					
New Martinsville, W. Va	1	1	< .2	1	6
Marietta, Ohio	1	< .2	< .2	2	5
Old Lock No. 19, W. Va	1	< .2	< .2	1	5
Addison, Ohio	1	2	1	3	11
Kyger Creek, W. Va	1	1	< .2	2	6
Boyd County, Ky	1	1	1	1	5
Meldahl Dam, Ohio	1	2	1	4	3
Madison, Ind	1	3	< .2	<1	2
Markland Dam, Ohio	1	3	< .2	1	3
Anderson Ferry, Ohio	1	2	< .2	14	6
Miami Fort, Ohio	1	2	1	4	2
Cincinnati, Ohio	3	(< .2, 1) < .7	(< .2, 1) < .5	(1, 11) 6.7	(4, 5) 4.3
Maysville, Ky	1	10	< .2	13	4
Portsmouth, Ohio	1	1	< .2	7	<1
Greenup Dam, Ky	1	1	< .2	1	4
Ironton, Ohio	1	1	< .2	8	5
Warwood, W. Va	1	1	1	4	6
Hancock, W. Va	1	1	< .2	1	6
South Heights, Pa	1	1	< .2	<1	10
Roanoke River:					
John Kerr Dam, Va	5	(< .2, 1) < .5	(< .2, 1) < .4	(< .2, 4) <1.8	(3, 4) 3.6
St. Lawrence River:					
Massena, N.Y	2	(< .2, < .2) < .2	(< .2, 1) < .6	(< .2, 1) < .6	(6, 7) 6.5
White Water Bridge:					
Suspension Bridge, Ohio	1	1	2	8	9

[a] When more than one sample is analyzed, the minimum and maximum values are in parentheses.

Water and Wastewater" (*1*). Results are reported for the date of counting and are not corrected to the date of collection. The sensitivity in counting is that defined by the National Bureau of Standards, Handbook 86 (*2*) and is calculated to be <0.2 pCi/liter for gross alpha and <1 pCi/liter for gross beta measurements.

REFERENCES

(*1*) AMERICAN PUBLIC HEALTH ASSOCIATION; AMERICAN WATER WORKS ASSOCIATION AND WATER POLLUTION CONTROL FEDERATION. Standard methods for the examination of water and wastewater, 13th Edition. New York, N.Y. (1971).

(*2*) U.S. DEPARTMENT OF COMMERCE. Radioactivity, Recommendations of the International Commission on Radiological Units and Measurements, NBS Handbook 86 (November 29, 1963).

Radioactivity in Minnesota Municipal Water Supplies[1] January-June 1970

Division of Environmental Sanitation
Minnesota Department of Health

The analysis of various Minnesota waters for radioactivity was initiated in 1956 as part of the Minnesota Water Pollution Control Program. This program was expanded in 1958 to include most of the municipal surface water supplies in the State, as well as selected lakes throughout the State.

As many as 25 surface streams and lakes involving 74 stations have been sampled. At present, nine surface streams and lakes used as municipal water supplies are sampled routinely (figure 1). "Grab" samples of raw and treated water are collected weekly at Hallock, East Grand Forks, Eveleth, Fairmont, and St. Paul. Beginning in November 1969, weekly samples from these stations were composited and analyzed on a monthly basis. Monthly samples are taken at Crookston, International Falls and St. Cloud. Minneapolis tap water is analyzed weekly. No raw water is collected from the Minneapolis supply.

The samples are forwarded to the Division's laboratory, where they are analyzed for gross alpha and beta radioactivity. A 500-ml sample of water is evaporated into a 2-inch aluminum milk bottle lid planchet and counted in an internal-proportional gas flow counter. Counter standardization is accomplished by adding known

[1] Data and information from "Survey of Environmental Radioactivity, January–June 1970," Publication No. C00-651-83. State of Minnesota Department of Public Health, University Campus, Minneapolis, Minn. 55440.

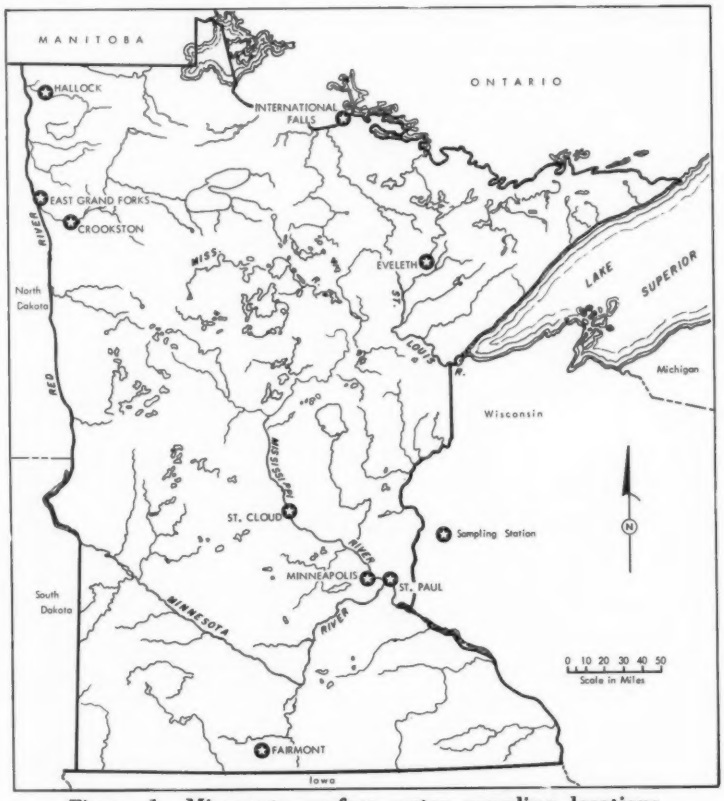

Figure 1. Minnesota surface water sampling locations

XUM

Table 1. Average gross beta radioactivity in Minnesota raw and treated water supplies January–June 1970

Town and water source	Type of water	Average concentrations (pCi/liter)					
		Jan	Feb	Mar	Apr	May	June
Crookston, Red Lake River	Raw	22	17	[a]16	(a)	27	28
	Treated	17	18	[a]19	(a)	14	19
East Grand Forks, Red Lake River	Raw	15	18	16	19	21	25
	Treated	10	8	11	9	11	11
Eveleth, St. Mary's Lake	Raw	12	11	10	11	12	10
	Treated	11	10	11	12	14	12
Fairmont, Budd Lake	Raw	11	11	8	13	13	11
	Treated	5	4	4	5	7	6
Hallock, Two Rivers South Fork	Raw	7	19	7	20	32	30
	Treated	20	5	6	11	15	13
International Falls, Rainy River	Raw	8	11	5	11	7	12
	Treated	14	11	6	NA	NA	11
Minneapolis tap water	Treated	5	5	2	6	7	5
St. Cloud, Mississippi River	Raw	[b] <2	(b)	[a]10	(a)	13	14
	Treated	[b]8	(b)	[a]4	(a)	3	6
St. Paul, Vadnais Chain of Lakes	Raw	6	8	8	10	25	11
	Treated	8	3	3	3	3	7

[a] March–April composite.
[b] January–February composite.
NA, no analysis.

Table 2. Average gross alpha radioactivity in Minnesota raw and treated water supplies, January–June 1970

Town and water source	Type of water	Average concentrations (pCi/liter)					
		Jan	Feb	Mar	Apr	May	June
Crookston, Red Lake River	Raw	<2	<1	[a] <2	(a)	6	6
	Treated	<2	<1	<1	<3	<3	<3
East Grand Forks, Red Lake River	Raw	<2	<2	<2	<4	<2	<3
	Treated	<2	<1	<1	<2	<1	<2
Eveleth, St. Mary's Lake	Raw	<1	<1	<1	<2	<1	<1
	Treated	<1	<1	<1	<2	<1	<1
Fairmont, Budd Lake	Raw	<3	4	<4	<4	6	<3
	Treated	<2	<2	<2	<2	<2	<2
Hallock, Two Rivers South Fork	Raw	<2	<3	<1	<4	3	<4
	Treated	<5	<2	<2	<2	<1	<2
International Falls, Rainy River	Raw	<1	<1	<1	<1	<1	1
	Treated	1	<1	<1	<1	NA	<1
Minneapolis tap water	Treated	<1	<1	<1	<1	<1	<2
St. Cloud, Mississippi River	Raw	[b] <1	(b)	[a] <1	(a)	<1	<3
	Treated	[b] <2	(b)	[a] <1	(a)	<1	<1
St. Paul, Vadnais Chain of Lakes	Raw	<2	<2	<3	<3	<1	<2
	Treated	<2	<1	<1	<1	<1	<3

[a] March–April composite.
[b] January–February composite.
NA, no analysis.

amounts of thallium-204 standard to solutions containing the normal range of solids.

Table 1 shows a summary of the monthly average gross beta radioactivity in Minnesota municipal water supplies from January–June 1970. Table 2 shows the gross alpha radioactivity in the same samples for the same period of time. Alpha concentrations reported as <1 pCi/liter were considered as 0 pCi/liter for averaging purposes.

The data obtained on gross beta radioactivity in Minnesota surface waters show a variation of concentrations, with no readily apparent trends. Variations in precipitation and flow rates of streams could contribute to this fluctuation. Monthly averages of gross beta radioactivity in Minnesota raw surface waters ranged from <2 to 32 pCi/liter, which is well below the Public Health Service Drinking Water Standards (*1*).

REFERENCE

(*1*) PUBLIC HEALTH SERVICE. Drinking water standards, revised 1962. Public Health Service Publication No. 956, Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (March 1963).

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
January–June 1969	January 1970
July–December 1969	May 1971

Tritium Surveillance System, April-June 1971

Office of Radiation Programs
Environmental Protection Agency

The Tritium Surveillance System is an expansion of previous tritium surveillance activities conducted by the Office of Radiation Programs, Environmental Protection Agency (EPA). The principal effort in the past by the Office of Radiation Programs related to tritium releases has been the Tritium in Surface Water Network. This network was established in 1964, to measure and monitor tritium concentrations in major river systems in the United States and to provide surveillance at surface water stations downstream from selected nuclear facilities. The network consisted of selected stations from existing water pollution sampling stations operated by the Office of Water Programs of EPA. The final data from this network for January–June 1970, have been published previously (*1*).

Another effort of the Office of Radiation Programs was a tritium in precipitation program. This project was established in 1967 at selected Radiation Alert Network (RAN) stations covering the United States, including Alaska and Hawaii. The RAN is operated by the National Environmental Research Laboratory of EPA. The data from this project for July–December 1969, have been published previously (*2*). Due to the increased interest in tritium releases from nuclear facilities and the potential long-term accumulation in the environment, a national system was established to incorporate these projects or networks into one overall system.

Present network

The Tritium Surveillance System consists of quarterly drinking water samples from 70 RAN stations, precipitation samples collected daily and analyzed monthly from 8 of the RAN stations and quarterly samples at 39 surface water

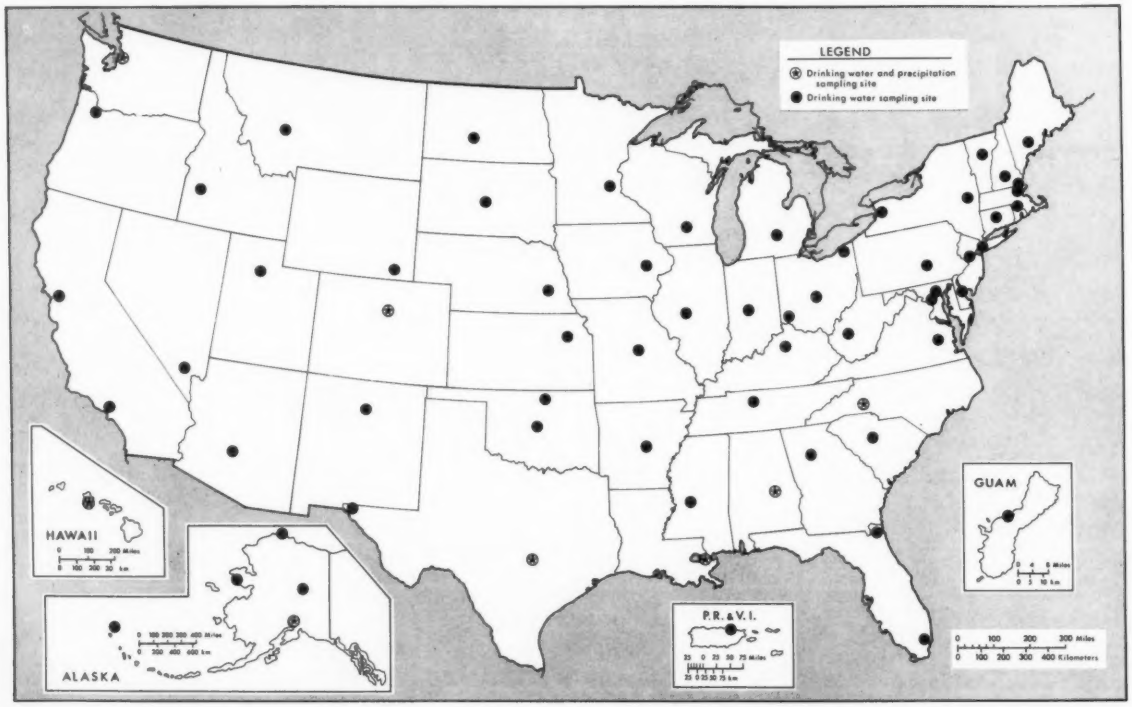

Figure 1. Drinking water and precipitation sampling locations for tritium surveillance system

Table 1. Tritium concentration in tap water (RAN stations) April–June 1971

Location		Date collected	Tritium concentration (nCi/liter ± 2σ)
Ala:	Montgomery	4/2	[a]0
Alaska:	Anchorage	NS	
	Attu Island	4/2	0
	Fairbanks	NS	
	Juneau	4/12	0
	Kodiak	4/1	.5 ± .4
	Nome	4/2	0
	Point Barrow	NS	
Ariz:	Phoenix	4/1	0
Ark:	Little Rock	4/1	[a]0
Calif:	Berkeley	4/1	0
	Los Angeles	4/8	0
C.Z:	Ancon	4/19	[a]0
Colo:	Denver	4/12	.9 ± .4
Conn:	Hartford	4/14	0
Del:	Dover	4/14	0
D.C:	Washington	5/7	.3 ± .2
Fla:	Jacksonville	4/1	[a]0
	Miami	4/5	[a]0
Ga:	Atlanta	4/1	[a]0
Guam:	Agana	4/1	0
Hawaii:	Honolulu	4/6	0
Idaho:	Boise	4/1	.7 ± .4
Ill:	Springfield	4/14	0
Ind:	Indianapolis	4/29	0
Iowa:	Iowa City	4/12	.5 ± .4
Kans:	Topeka	4/12	1.0 ± .4
Ky:	Frankfort	4/1	.4 ± .2
La:	New Orleans	4/1	.3 ± .2
Maine:	Augusta	4/13	0
Md:	Baltimore	4/5	.3 ± .2
Mass:	Lawrence	4/12	0
	Winchester	4/7	0
Mich:	Lansing	4/22	0
Minn:	Minneapolis	4/7	.7 ± .4
Miss:	Jackson	4/1	[a]0
Mo:	Jefferson City	4/5	0
Mont:	Helena	4/6	.9 ± .4
Nebr:	Lincoln	4/5	0
Nev:	Las Vegas	4/1	0
N.H:	Concord	4/12	0
N.J:	Trenton	4/12	0
N.Mex:	Sante Fe	4/1	0
N.Y:	Albany	4/13	0
	Buffalo	4/22	0
	New York City	6/7	0
N.C:	Gastonia	4/23	.3 ± .2
N. Dak:	Bismarck	4/20	1.5 ± .4
Ohio:	Cincinnati	4/15	0
	Columbus	4/14	0
	Painesville	4/16	0
Okla:	Oklahoma City	4/2	.4 ± .2
	Ponca City	4/2	.3 ± .2
Oreg:	Portland	4/13	0
Pa:	Harrisburg	4/13	0
P.R:	San Juan	4/26	[a]0
R.I:	Providence	4/20	0
S.C:	Columbia	4/1	[a]0
S. Dak:	Pierre	4/1	1.6 ± .4
Tenn:	Nashville	4/1	[a]0
Tex:	Austin	4/2	.3 ± .2
	El Paso	4/9	.4 ± .2
Utah:	Salt Lake City	4/6	.5 ± .4
Vt:	Barre	4/12	0
Va:	Richmond	4/8	.3 ± .1
Wash:	Seattle	6/16	0
	Spokane	4/5	0
W. Va:	Charleston	4/1	.3 ± .2
Wisc:	Madison	4/15	0
Wyo:	Cheyenne	4/2	1.2 ± .4
Average[b]			0.2

[a] The minimum detection limit for this sample was 0.2 nCi/liter. All values equal to or less than 0.2 nCi/liter have been reported as zero. For all other zero numbers, the minimum detection limit was 0.4 nCi/liter and all values equal to or less than 0.4 nCi/liter have been reported as zero.

[b] This is the average of all concentration values as shown in the table. It should be noted that due to varying sensitivities of procedures between the three laboratories, two different minimum detectable concentrations are used.

NS, no sample.

Table 2. Tritium concentration in surface water, March–June 1971

Location	Water source	Facility	Collection date	Concentration (nCi/liter ± 2σ)
Ala: Decatur	Tennessee River	Browns Ferry	4/31	0.5 ± .2
Ark: Morrilton	Arkansas River	Arkansas Nuclear	4/15	.3 ± .2
Calif: Eureka	Humboldt Bay	Humboldt Bay	4/16	0
San Onofre	Pacific Ocean	San Onofre	5/25	0
Colo: Greeley	South Platte River	Fort St. Vrain	4/12	1.3 ± .4
Conn: East Haddam	Connecticut River	Connecticut Yankee & Vermont Yankee	4/23	1.7 ± .4
Waterford	Long Island Sound	Millstone	4/9	0
Fla: Crystal River	Gulf of Mexico	Crystal River	5/10	[a]0
Homestead	Biscayne Bay	Turkey Point	5/17	[a]0
Idaho: Buhl	Snake River	National Reactor Testing Station	4/3	.6 ± .4
Ill: Moline	Mississippi River	Quad-Cities	5/3	0
Morris	Illinois River	Dresden and Argonne	4/16	0
La: New Orleans	Mississippi River	(Several)	4/15	.5 ± .2
Md: Conowingo	Susquehanna River	Peach Bottom and Three Mile Island	4/22	0
Lusby	Chesapeake Bay	Calvert Cliffs	6/28	0
Mass: Rowe	Deerfield River	Yankee	5/5	.5 ± .4
Mich: Charlevoix	Lake Michigan	Big Rock Point	5/1	0
Monroe	Lake Erie	Enrico Fermi	5/3	0
South Haven	Lake Michigan	Palisades	4/26	0
Minn: Monticello	Mississippi River	Monticello	4/6	.7 ± .4
Nebr: Rulo	Missouri River	Fort Calhoun and Cooper	4/7	.7 ± .4
Nev: Boulder City	Colorado River	Background	4/1	1.0 ± .4
N.J: Bayside	Delaware River	Salem	4/5	0
N.Y: Ossining	Hudson River	Indian Point	4/19	0
Oswego	Lake Ontario	Nine Mile Point and R. E. Ginna	4/14	0
Poughkeepsie	Hudson River	Background	4/21	0
N.C: Charlotte	Catawba River	Wm B. McGuire	4/21	.4 ± .2
Oreg: Westport	Columbia River	Rainier and Hanford	4/2	1.0 ± .4
S.C: Allendale	Savannah River	Savannah River Plant and Oconee	4/6	4.0 ± .2
Hartsville	Lake Robinson	H. B. Robinson	4/1	.7 ± .2
Tenn: Kingston	Clinch River	Oak Ridge	4/5	7.0 ± .3
Tex: El Paso	Rio Grande River	Los Alamos	4/5	0
Vt: Vernon	Connecticut River	Vermont Yankee	4/9	0
Va: Newport News	James River	Surry	NS	
Wash: Northport	Columbia River	Background	5/5	.9 ± .4
Pasco	Columbia River	Hanford	4/6	.9 ± .4
W.Va: Wheeling	Ohio River	Shippingport	4/14	0
Wisc: Two Creeks	Lake Michigan	Point Beach and Kewaunee	4/26	0
Victory	Mississippi River	LaCrosse and Prairie Island	4/16	0
Average[b]				0.6

[a] The minimum detection limit for this sample was 0.2 nCi/liter. All values equal to or less than 0.2 nCi/liter have been reported as zero. For all other numbers, the minimum detection limit was 0.4 nCi/liter and all values equal to or less than 0.4 nCi/liter have been reported as zero.

[b] This is the average of all concentration values as shown in the table. It should be noted that due to varying sensitivities of procedures between the three laboratories, two different minimum detectable concentrations are used.

NS, no sample.

stations (figure 1). The specific locations for the surface water sampling system were determined by examining the water drainage areas to assure that a representative sample from a large area or region was obtained, and if possible, incorporating several nuclear facility sites. All nuclear facilities that were operating, being constructed, or planned through 1975 were considered. Consideration was also given to the current surveillance programs of the States that will be involved in the collection of the samples. The surface water samples are collected quarterly either downstream from a nuclear facility or at a background station.

The tap water samples are collected by the RAN operators on a quarterly basis. The precipitation samples are also collected by the RAN operators on a daily basis.

All samples are sent to one of our laboratories for analysis. Due to the different sensitivity of procedures used by the three laboratories, the minimum detectable concentration varies. Analytical values which are not statistically significant at the 2-sigma confidence level have been reported as zero.

Results and discussion

Table 1 presents the tritium concentrations in drinking water at the RAN stations for April–June 1971. The average tritium concentration was 0.2 nCi/liter.

The radiation dose resulting from the observed tritium concentrations in the drinking water may be evaluated by using the relationship derived by Moghissi and Porter (*3*) from recommendations of the International Commission of Radiological Units and Measurements (*4*). Assuming that the concentration of tritium in all water taken into the body is equal to that found in the drinking water and also that the specific activity of tritium in the body is essentially the same as that in the

XUM

drinking water, then the radiation dose may be estimated.

The highest individual concentration of tritium observed in the drinking water was 1.7 nCi/liter during the second quarter. This corresponds to a dose of 0.3 mrem/a, or less than 0.2 percent of the Federal Radiation Council's Radiation Protection Guide (170 mrem/a) for an average dose to a suitable sample of the exposed population.

The tritium concentrations for the surface water samples are given in table 2. The highest tritium concentration was 7.0 nCi/liter for the second quarter. Assuming that the specific activity of tritium in the body is essentially the same as that in surface water, this concentration corresponds to a dose of 1.2 mrem/a, or 0.7 percent of the Radiation Protection Guide.

The monthly analyses for tritium in precipitation samples at the 8 RAN stations are shown in table 3.

Other coverage in *Radiological Health Data and Reports:*

Period	Issue
July–December 1970	May 1971
January–March 1971	July 1971

Table 3. Tritium concentrations in precipitation from RAN stations, April–June 1971

Location		Tritium concentration[a] (nCi/liter $\pm 2\sigma$)		
		April	May	June
Ala:	Montgomery	0	0.7±0.2	0.3±0.2
Alaska:	Anchorage	NS	.4± .2	NS
Colo:	Denver	1.3±0.2	1.6± .2	1.6± .2
Hawaii:	Honolulu	0	NS	0
La:	New Orleans	.4± .2	0	0
N.C:	Gastonia	.4± .2	.3± .2	.6± .2
Tex:	Austin	NS	NS	NS
Wash:	Seattle	.3± .2	.4± .2	.7± .2

[a] The minimum detection limit for these samples was 0.2 nCi/liter. All values equal to or less than 0.2 nCi/liter have been reported as zero.
NS, no sample.

REFERENCES

(1) BUREAU OF RADIOLOGICAL HEALTH. Tritium in surface water network, January–June 1970. Radiol Health Data Rep 11:638–639 (November 1970).

(2) BUREAU OF RADIOLOGICAL HEALTH. Tritium in precipitation (RAN), July–December 1969. Radiol Health Data Rep 11:354–355 (July 1970).

(3) MOGHISSI, A. A. and C. R. PORTER. Tritium in surface waters in the United States, 1966. Radiol Health Data Rep 9:337–339 (July 1968).

(4) INTERNATIONAL COMMISSION OF RADIOLOGICAL UNITS AND MEASUREMENTS. Recommendations of the International Commission of Radiological Units and Measurements, National Bureau of Standards Handbook 85 (1964).

SECTION III. AIR AND DEPOSITION

Radioactivity in Airborne Particulates and Precipitation

Continuous surveillance of radioactivity in air and precipitation provides one of the earliest indications of changes in environmental fission product radioactivity. To date, this surveillance has been confined chiefly to gross beta radioanalysis. Although such data are insufficient to assess total human radiation exposure from fallout, they can be used to determine when to modify monitoring in other phases of the environment.

Surveillance data from a number of programs are published monthly and summarized periodically to show current and long-range trends of atmospheric radioactivity in the Western Hemisphere. These include data from activities of the Environmental Protection Agency, the Canadian Department of National Health and Welfare, the Mexican Commission of Nuclear Energy, and the Pan American Health Organization.

In addition to those programs presented in this issue, the following programs were previously covered in *Radiological Health Data and Reports:*

Network	Period	Issue
Fallout in the United States and other areas	July–December 1968 and January–December 1969	January 1971
Plutonium in Airborne Particulates	July–December 1970	June 1971
Surface Air Sampling Program 80th Meridian Network, *HASL*	January–December 1968	April 1971
Mexican Air Monitoring Program	August–December 1970 and January 1971	October 1971

XUM

1. Radiation Alert Network July 1971

National Environmental Research Laboratory
Environmental Protection Agency

Surveillance of atmospheric radioactivity in the United States is conducted by the Radiation Alert Network (RAN) which regularly gathers samples at 70 locations distributed throughout the country (figure 1). Most of these stations are operated by State Health Department personnel.

The station operators perform "field estimates" on the airborne particulate samples at 5 hours after collection, when most of the radon daughter products have decayed. They also perform field estimates on dried precipitation samples and report all results to appropriate Environmental Protection Agency officials by mail or telephone depending on levels found. A complication of the daily field estimates is available upon request from the Data Aquisition and Analysis Branch, Division of Air Quality and Emission Data, EPA, Durham, N.C. A detailed description of the sampling and analytical procedures was presented in the March 1968 issue of *Radiological Health Data and Reports.*

Table 1 presents the monthly average gross beta radioactivity in surface air particulates and deposition by precipitation, as measured by the field estimate technique, during July 1971. All field estimates reported were within normal limits for the reporting station.

Figure 1. Radiation Alert Network sampling stations

Table 1. Gross beta radioactivity in surface air and precipitation, July 1971

Station location		Number of samples	Gross beta radioactivity (5-hour field estimate) (pCi/m³)			Number of samples	Total depth (mm)	Precipitation		
								Field estimation of deposition		
			Maximum	Minimum	Average[a]			Number of samples	Depth (mm)	Total deposition (nCi/m²)
Ala:	Montgomery	21	4	0	1	10	504	10	504	148
Alaska:	Anchorage	0				0				
	Attu Island	30	0	0	0	0				
	Fairbanks	17	2	0	1	7	32	7	32	14
	Juneau	10	2	0	1	0				
	Kodiak	1	0	0	0	0				
	Nome	0				0				
	Point Barrow	0				0				
Ariz:	Phoenix	12	4	1	2	0				
Ark:	Little Rock	12	1	0	0	0				
Calif:	Berkeley	21	1	0	0	0				
	Los Angeles	20	2	0	1	0				
C.Z:	Ancon	16	0	0	0	0				
Colo:	Denver	21	5	1	2	3	26	[b]		
Conn:	Hartford	21	2	0	1	6	72	6	72	1
Del:	Dover	20	2	0	1	0				
D.C:	Washington	27	2	0	1	0				
Fla:	Jacksonville	22	1	0	0	10	529	10	529	45
	Miami	20	0	0	0	4	82	4	82	0
Ga:	Atlanta	11	2	1	1	0				
Guam:	Agana	0				0				
Hawaii:	Honolulu	24	1	0	0	1	5	[b]		
Idaho:	Boise	21	3	0	2	0				
Ill:	Springfield	0				0				
Ind:	Indianapolis	19	2	0	1	0				
Iowa:	Iowa City	20	4	1	1	7	150	7	150	0
Kans:	Topeka	21	5	1	2	8	116	8	116	0
Ky:	Frankfort	1	1	1	1	0				
La:	New Orleans	17	1	0	0	12	244	[b]		
Maine:	Augusta	17	2	0	1	6	107	6	107	0
Md:	Baltimore	21	3	0	1	5	44	5	44	0
Mass:	Lawrence	21	2	0	1	6	79	5	59	1
	Winchester	21	2	1	1	5	61	5	61	0
Mich:	Lansing	19	2	1	1	7	93	7	93	8
Minn:	Minneapolis	21	2	0	1	8	128	8	128	37
Miss:	Jackson	19	2	0	1	5	126	5	126	6
Mo:	Jefferson City	22	5	1	2	8	90	8	90	0
Mont:	Helena	19	3	0	1	2	11	2	11	0
Nebr:	Lincoln	21	13	1	4	3	47	3	47	3
Nev:	Las Vegas	21	3	1	1	0				
N.H:	Concord	0				0				
N.J:	Trenton	21	2	0	1	6	83	6	83	9
N. Mex:	Santa Fe	19	2	0	1	7	71	5	40	4
N.Y:	Albany	20	3	0	1	0				
	Buffalo	20	2	0	1	0				
	New York City	0				0				
N.C:	Gastonia	16	3	0	2	7	73	[b]		
N. Dak:	Bismarck	21	4	1	2	2	24	2	24	1
Ohio:	Cincinnati	0				0				
	Columbus	3	2	1	1	0				
	Painesville	20	5	1	2	7	60	7	60	62
Okla:	Oklahoma City	0				0				
	Ponca City	21	5	1	1	8	102	8	102	0
Oreg:	Portland	20	1	0	1	1	3	1	3	0
Pa:	Harrisburg	16	2	0	1	0				
P.R:	San Juan	0				0				
R.I:	Providence	20	2	0	1	4	67	4	67	2
S.C:	Columbia	17	2	0	1	10	277	10	277	0
S. Dak:	Pierre	15	6	1	3	0				
Tenn:	Nashville	21	3	0	1	11	114	11	114	8
Tex:	Austin	0				0				
	El Paso	18	3	0	1	0				
Utah:	Salt Lake City	31	5	1	2	1	20	1	20	6
Vt:	Barre	22	4	0	2	9	109	9	109	12
Va:	Richmond	20	2	0	1	1	21	1	21	18
Wash:	Seattle	9	0	0	0	2	13	[b]		
	Spokane	15	2	0	1	0				
W. Va:	Charleston	19	2	0	1	8	126	8	126	16
Wisc:	Madison	20	2	1	1	6	63	6	63	5
Wyo:	Cheyenne	22	7	0	3	1	8	1	8	13
Network summary		1,093	13	0	1	214	118	6	105	13

[a] The monthly average is calculated by weighting the field estimates of individual air samples with length of sampling period.
[b] This station is part of the tritium surveillance system. No gross beta measurements are done.

XUM

2. Canadian Air and Precipitation Monitoring Program,[1] July 1971

Radiation Protection Division
Department of National Health and Welfare

The Radiation Protection Division of the Canadian Department of National Health and Welfare monitors surface air and precipitation in connection with its Radioactive Fallout Study Program. Twenty-four collection stations are located at airports (figure 3), where the sampling equipment is operated by personnel from the Meteorological Services Branch of the Department of Transport. Detailed discussions of the sampling procedures, methods of analysis, and interpretation of results of the radioactive fallout program are contained in reports of the Department of National Health and Welfare (*1–5*).

A summary of the sampling procedures and methods of analysis was presented in the May 1969 issue of *Radiological Health Data and Reports.*

Surface air and precipitation data for July 1971 are presented in table 2.

[1] Prepared from information and data obtained from the Canadian Department of National Health and Welfare, Ottawa, Canada.

Table 2. Canadian gross beta radioactivity in surface air and precipitation, July 1971

Station	Number of samples	Air surveillance gross beta radioactivity (pCi/m³)			Precipitation measurements	
		Maximum	Minimum	Average	Average concentration (pCi/liter)	Total deposition (nCi/m²)
Calgary	4	0.5	0.3	0.4	87	6.4
Coral Harbour	3	.2	.1	.1	188	3.7
Edmonton	4	.4	.3	.3	47	8.6
Ft. Churchill	4	.3	.1	.2	199	11.2
Fredericton	4	.4	.2	.3	116	8.9
Goose Bay	4	.4	.1	.2	40	4.9
Halifax	4	.3	.2	.3	58	6.1
Inuvik	4	.2	.1	.1	412	10.2
Montreal	4	.4	.2	.3	191	10.8
Moosonee	4	.4	.1	.3	75	7.1
Ottawa	4	.5	.2	.3	135	15.1
Quebec	4	.4	.3	.4	167	19.6
Regina	4	.5	.3	.4	279	12.2
Resolute	4	.2	.1	.1	NS	NS
St. John's, Nfld.	4	.3	.1	.2	72	10.6
Saskatoon	4	.4	.2	.3	155	22.0
Sault Ste. Marie	4	.3	.2	.3	174	13.5
Thunder Bay	4	.3	.2	.3	127	11.9
Toronto	4	.5	.3	.4	167	9.9
Vancouver	4	.3	.1	.2	124	4.2
Whitehorse	4	.5	.3	.4	139	4.5
Windsor	4	.5	.4	.4	36	1.7
Winnipeg	4	.4	.2	.3	192	22.1
Yellowknife	4	.2	.1	.1	410	4.6
Network summary	95	0.5	0.1	0.3	156	10.0

NS, no sample.

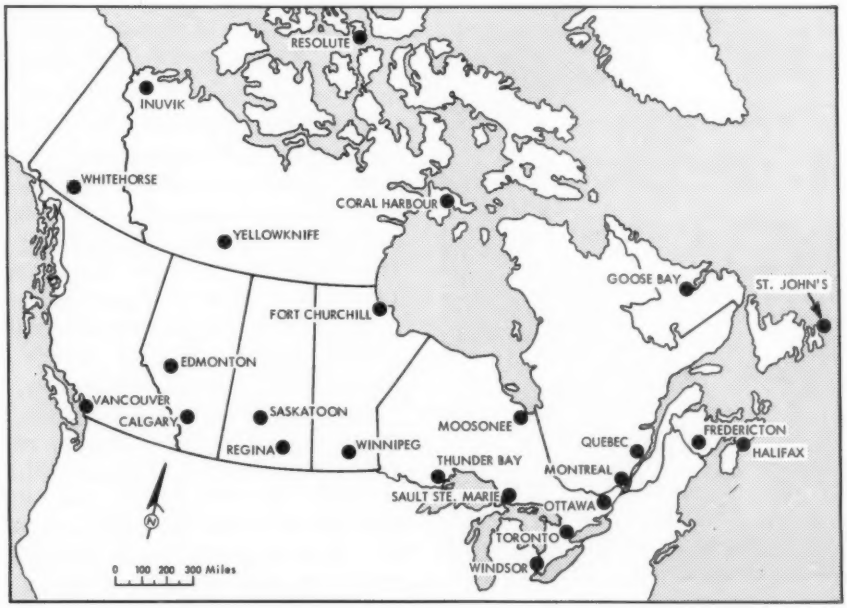

Figure 2. Canadian air and precipitation sampling stations

3. Pan American Air Sampling Program July 1971

Pan American Health Organization and
Environmental Protection Agency

Gross beta radioactivity in air is monitored by countries in the Americas under the auspices of the collaborative program developed by the Pan American Health Organization (PAHO) and the Environmental Protection Agency (EPA) to assist PAHO-member countries in developing radiological health programs.

The air sampling station locations are shown in figure 3. Analytical techniques were described in the March 1968 issue of *Radiological Health Data and Reports*. The July 1971 air monitoring results from the participating countries are given in table 3.

Table 3. Summary of gross beta radioactivity in Pan American surface air, July 1971

Station		Number of samples	Gross beta radioactivity (pCi/m³)		
			Maximum	Minimum	Average
Argentina:	Buenos Aires	0			
Bolivia:	La Paz	18	5.69	0.41	2.25
Chile:	Santiago	30	3.11	.04	1.26
Colombia:	Bogota	0			
Ecuador:	Cuenca	0			
	Guayaquil	21	5.31	.09	1.90
	Quito	19	.55	.02	.20
Guyana:	Georgetown	0			
Jamaica:	Kingston	0			
Peru:	Lima	22	4.48	.39	1.94
Venezuela:	Caracas	18	.31	.02	.21
West Indies:	Trinidad	19	.57	.16	.30
Pan American summary		147	5.69	0.02	1.18

[a] The monthly average is calculated by weighting the individual samples with length of sampling period. Values less than 0.005 pCi/m³ are reported and used in averaging as 0.00 pCi/m³.

Figure 3. Pan American Air Sampling Program stations

4. Plutonium in Airborne Particulates January–March 1971

Office of Radiation Programs
Environmental Protection Agency

The Radiation Alert Network (RAN) of the Environmental Protection Agency routinely collects airborne particulate samples from eleven selected RAN stations for plutonium analyses. The plutonium analyses were initiated in November 1965 and references to the previous results through December 1969 have been published (*6*).

One-half of each individual air filter from the selected stations is sent to the Northeastern Radiological Health Laboratory, Winchester, Mass. The laboratory analyzes a composite of these samples for each station on a quarterly basis. The results for January–March 1971 are presented in table 4. The minimum detectable activities are 0.020 pCi and 0.015 pCi per sample for plutonium-238 and plutonium-239, respectively. The volume of air sampled varies, generally ranging from 20,000 to 30,000 cubic meters per month.

Table 4. Plutonium in airborne particulates January–March 1971

Location	Plutonium-238 (aCi/m³)	Plutonium-239 (aCi/m³)	$^{239}Pu/^{238}Pu$
Alaska: Anchorage	3±1	13± 1	4.3±1.5
Ariz: Phoenix	10±3	68±11	6.8±2.3
Colo: Denver	9±4	55±11	6.1±3.0
Hawaii: Honolulu	3±1	32± 3	10.7±3.7
La: New Orleans	9±6	51±17	5.7±4.2
Md: Baltimore	ND	18± 1	—
N.Y: Buffalo	5±2	28± 6	5.6±2.5
N.C: Gastonia	8±2	56± 5	7.0±1.9
S.Dak: Pierre	ND	39±11	—
Tex: Austin	NA	35± 4	—
Wash: Seattle	2±1	19± 1	9.5±4.8

ND, nondetectable.
NA, no analysis.

Errata: Some previous tables presenting data for plutonium-238 and plutonium-239 in airborne particulates have been in error. The following are corrections or additions to previous data:

a. Corrections—*Radiological Health Data and Reports*—9:761–763 (December 1968)

S. Dak: Pierre—November 1967
plutonium-238 0.0024 fCi/m³

Tex: Austin—October 1967
plutonium-239 .0195 fCi/m³

Ariz: Phoenix—November 1967
plutonium-238 .0066 fCi/m³

Hawaii: Honolulu—November 1967
plutonium-238 .0025 fCi/m³

b. Additions—*Radiological Health Data and Reports*—11:311–312 (June 1970)

Colo: Denver—August–September 1968
plutonium-238 0.019 fCi/m³
plutonium-239 .035 fCi/m³
$^{239}Pu/^{238}Pu$ 1.8

October–December 1968
plutonium-238 .012 fCi/m³
plutonium-239 .110 fCi/m³
$^{239}Pu/^{238}Pu$ 9.2

Md: Rockville—October–December 1968
plutonium-238 .006 fCi/m³
plutonium-239 .010 fCi/m³
$^{239}Pu/^{238}Pu$ 1.7

S. Dak: Pierre:—October–December 1968
plutonium-238 .008 fCi/m³
plutonium-239 .028 fCi/m³
$^{239}Pu/^{238}Pu$ 3.5

REFERENCES

(1) BIRD, P. M., A. H. BOOTH, and P. G. MAR. Annual report of 1959 on the Radioactive Fallout Study Program, CNHW-RP-3. Department of National Health and Welfare, Ottawa, Canada (May 1960).

(2) BIRD, P. M., A. H. BOOTH, and P. G. MAR. Annual report for 1960 on the Radioactive Fallout Study Program, CNHW-RP-4. Department of National Health and Welfare, Ottawa, Canada (December 1961).

(3) MAR, P. G. Annual report for 1961 on the Radioactive Fallout Study Program, CNHW-RP-5. Department of National Health and Welfare, Ottawa, Canada (December 1962).

(4) BEALE, J. and J. GORDON. The operation of the Radiation Protection Division Air Monitoring Program, RPD-11. Department of National Health and Welfare, Ottawa, Canada (July 1962).

(5) BOOTH, A. H. The calculation of permissible levels of fallout in air and water and their use in assessing the significance of 1961 levels in Canada, RPD-21. Department of National Health and Welfare, Ottawa, Canada (August 1962).

(6) BUREAU OF RADIOLOGICAL HEALTH. Plutonium in airborne particulates, April–December 1969. Radiol Health Data Rep 11:552–553 (October 1970).

Other coverage in *Radiological Health Data and Reports:*

Period	Issue
January–June 1970	March 1971
July–December 1970	June 1971

SECTION IV. OTHER DATA

This section presents results from routine sampling of biological materials and other media not reported in the previous sections. Included here are such data as those obtained from human bone sampling, Alaskan surveillance, and environmental monitoring around nuclear facilities.

Environmental Levels of Radioactivity at Atomic Energy Commission Installations

The U.S. Atomic Energy Commission (AEC) receives from its contractors semiannual reports on the environmental levels of radioactivity in the vicinity of major Commission installations. The reports include data from routine monitoring programs where operations are of such a nature that plant environmental surveys are required.

Releases of radioactive materials from AEC installations are governed by radiation standards set forth by AEC's Division of Operational Safety in directives published in the "AEC Manual."[1]

Summaries of the environmental radioactivity data follow for Bettis Atomic Power Laboratory and the Oak Ridge Area.

[1] Title 10, Code of Federal Regulations, Part 20, "Standards for Protection Against Radiation" contains essentially the standards published in Chapter 0524 of the AEC Manual.

1. Bettis Atomic Power Laboratory[2] January–December 1970

Westinghouse Electric Corporation
Pittsburgh, Pa.

The Bettis Atomic Power Laboratory (BAPL), operated for the Atomic Energy Commission by the Westinghouse Electric Corporation, was established in 1949 to conduct research and development operations related to naval atomic propulsion systems and to the central station power reactor at Shippingport, Pa. Routine environmental monitoring data are reported for samples taken from the locations shown in figure 1.

Gaseous radioactive waste

The release of gaseous radioactive waste is monitored by continuous air sampling to assure compliance with laboratory regulations. The stack gas limits for the laboratory are based on the 168-hour nonoccupational maximum permissible concentrations in air as specified in AEC Manual Chapter 0524. At no time during 1970 did the concentration of stack releases exceed the required limits. The general public outside the boundary of the laboratory was not exposed to radiation above normal background levels as a result of operations at Bettis.

Total gaseous radioactivity released to the environment during 1970 was 1.64 mCi alpha and less than 164 mCi beta-gamma. Due to a decreased volume of air discharged, the total radioactivity was 13 percent less than last year's quantities; the average concentration of radioactivity, however, remained the same.

Liquid radioactive waste

Radioactive liquids generated in the main laboratory and critical facility areas are collected in retention tanks and sampled for radioanalysis. The laboratory discharge limit of 2,000 pCi/liter is in compliance with AEC Manual Chapter 0524. If activity of liquid wastes is greater than the discharge limit, the water is processed by ion

[2] Summarized from "Bettis Atomic Power Laboratory, Environmental Monitoring Report, Calendar Year 1970" (WAPD-CL(RA)E-404).

XUM

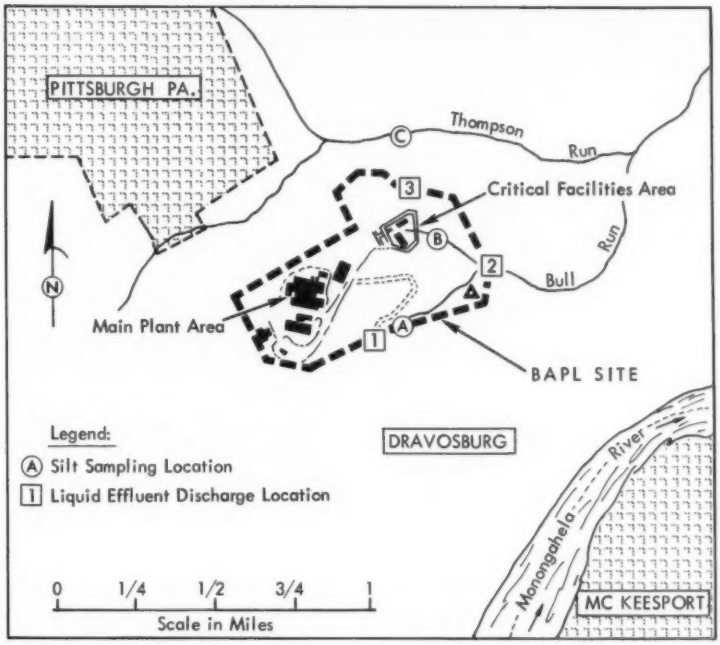

Figure 1. Bettis Atomic Power Laboratory sampling stations

exchange or evaporation. Water less than the discharge limit is released to the storm sewer and diluted with laboratory coolant water, process water, and surface runoff water. This plant effluent is discharged from laboratory property at the three locations shown in figure 1. A composite of the main laboratory effluent released at location 1, is collected and analyzed weekly for gross radioactivity. Critical facility effluent suitable for release is discharged at locations 2 and 3.

The plant effluent water analysis data are summarized in table 1. This shows that the average concentration of the laboratory effluent water is well below the discharge limit of 34 pCi/liter or 1.7 percent of the laboratory discharge limit. The total radioactivity discharged from Bettis Laboratory during 1970 which can be attributed to laboratory operations was 9.9 millicuries.

The average concentrations of gross beta-gamma radioactivity in the main laboratory

Table 1. Average concentration of radioactivity in the Bettis Laboratory liquid effluent, January–December 1970[a]

Period (1970)	Main laboratory			Critical facility		
	Gross radioactivity (pCi/liter)		Volume (10^6 gallons)	Gross radioactivity (pCi/liter)		Volume (10^3 gallons)
	Beta-gamma	Alpha		Beta-gamma	Alpha[b]	
January–March	53	5.1	34.2	560	75	21.0
April–June	31	3.9	52.6	<550	51	68.5
July–September	17	3.2	66.1	<550	<50	4.0
October–December	35	1.6	45.3	800	190	9.5
Summary	31	3.2	198.6	570	68	103.0

[a] Discharge limit 2,000 pCi/liter gross radioactivity. The critical facility effluent is just monitored process water whereas the main laboratory effluent includes the complete storm sewer flow.

[b] Minimum detectable levels for alpha radioactivity for the analytical technique used are 0.1 pCi/liter (main laboratory) and 50 pCi/liter (critical facility). Minimum detectable levels for beta-gamma radioactivity are 0.2 pCi/liter (main laboratory) and 550 pCi/liter (critical facility).

liquid effluent during 1970 was 31 pCi/liter. This was slightly higher than the average concentration of 28 pCi/liter observed for the year 1969.

Average radioactivity in liquid waste effluent from the critical facility operations during 1970 were 68 pCi/liter of alpha radioactivity and 570 pCi/liter of beta-gamma radioactivity. Comparable values for 1969 were <330 pCi/liter for alpha radioactivity and 1.2 nCi/liter for beta-gamma radioactivity.

Background monitoring stations

Background beta-gamma radiation levels were continuously monitored and recorded at 34 film badge monitoring stations located along the perimeter fence of the laboratory which lies within the controlled confines of the Bettis Atomic Power Laboratory site. In addition, control badges were placed at locations not affected by laboratory operations. These were used to determine the net background radiation level contributed by the laboratory. The results obtained from the environmental monitoring film badges posted at these locations around the laboratory show that radiation exposure to the general public outside the laboratory was not above that received from natural background radiation levels.

Stream silt

Stream silt samples were collected periodically at the three discharge locations (figure 1). The results of analysis of these samples are presented in table 2. The average alpha and beta-gamma radioactivity concentrations of stream silt samples for 1970 were 7.7 pCi/g and 64.4 pCi/g, respectively. These concentrations are consistent with concentrations detected in previous years.

Semiannual analyses for strontium-89 and strontium-90 were obtained for composites of silt samples. Table 2 presents the results of these analyses for samples collected during 1970.

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
January–December 1968	January 1970
January–December 1969	September 1970

Table 2. Radioactivity in stream silt, Bettis, January-December 1970

Period (1970)	Number of samples	Radioactivity (pCi/g)				Average concentration (pCi/g)	
		Alpha		Beta-gamma		Strontium-89	Strontium-90
		Range	Average	Range	Average		
Bull Run Stream	4	5.1– 9.0	7.2	54–117	100	0.50	0.87
C-Area Stream	2	9.4–10.0	9.7	28– 33	30	.17	.28
Thompson Run Stream	2	4.3– 9.0	6.6	25– 27	26	.05	.25
Streets Run (Control Stream)	2	2.0– 5.1	3.5	22– 23	23	.17	.29

XUM

2. Oak Ridge Area[3] January–June 1970

Union Carbide Nuclear Company
Oak Ridge, Tenn.

Oak Ridge area is a complex made up primarily of the Y-12 Plant, the Oak Ridge National Laboratory (ORNL), and the Oak Ridge Gaseous Diffusion Plant (ORGDP).

Radioactive waste materials arising from the operation of atomic energy installations in the Oak Ridge area are collected, treated, and disposed of according to their physical states. Solid wastes are buried in a Conasauga shale formation which has a marked ability to fix radioactive materials by an ion exchange mechanism. Liquid wastes which contain long-lived fission products are confined in storage tanks or are concentrated by evaporation and disposed of in deep wells. Low-level liquid wastes are discharged after preliminary treatment to the surface streams. Air that may become contaminated by radioactive materials is exhausted to the atmosphere from several tall stacks after treatment by means of scrubbers and filters.

[3] Summarized from "Environmental Levels of Radioactivity for the Oak Ridge area, January–June 1970." Health Physics and Safety Section, Health Physics Division, Oak Ridge National Laboratory.

Air monitoring

Atmospheric contamination by radioactive materials occurring in the general environment of East Tennessee is monitored by two systems of monitoring stations. One system consists of nine stations which encircle the plant areas (figure 2) and provide data for evaluating the impact of all Oak Ridge operations on the immediate environment. A second system consists of eight stations encircling the Oak Ridge area at distances of from 12 to 75 miles (figure 3). This system provides data to aid in evaluating local conditions and to assist in determining the spread or dispersal of contamination should a major incident occur.

Sampling for radioactive particulates is carried out by passing air continuously through a filter paper. Average radioactivity concentrations are presented in tables 3 and 4. Airborne radioactive iodine is monitored in the immediate environment of the plant areas by passing air through a cartridge containing activated charcoal.

During the January–June 1970 surveillance period, 244 samples were collected from perim-

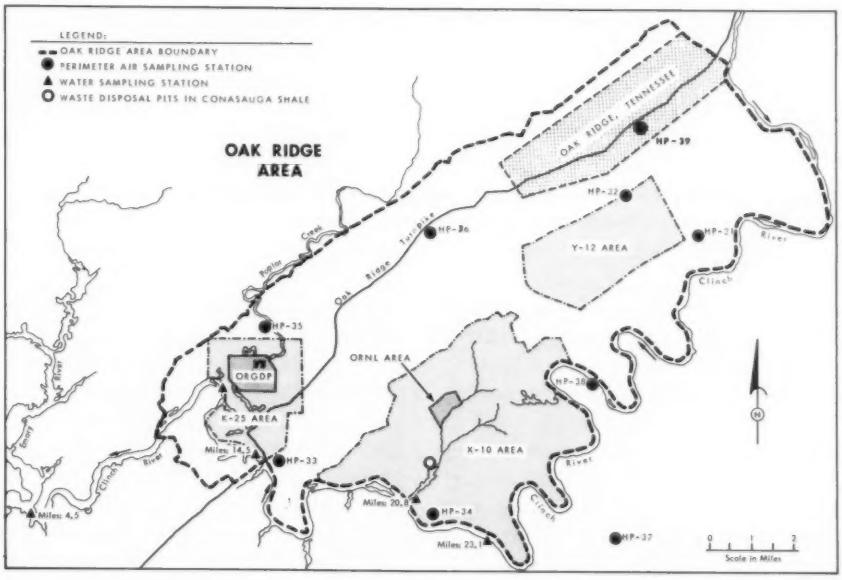

Figure 2. Oak Ridge Area environmental sampling locations

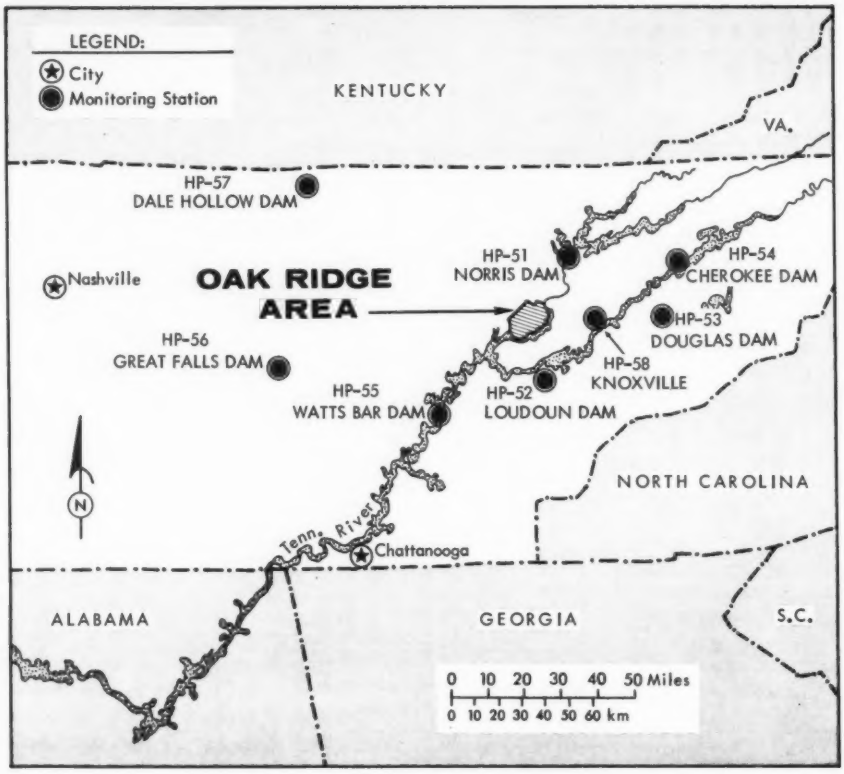

Figure 3. Remote air monitoring stations, Oak Ridge area

Table 3. Long-lived gross beta radioactivity of particulates in air, Oak Ridge area, January–June 1970

Perimeter stations						Remote stations					
Station number (figure 3)	Number of samples	Concentration (fCi/m³)			Percent of AEC standard[c]	Station number (figure 2)	Number of samples	Concentration (fCi/m³)			Percent of AEC standard[c]
		Maximum[a]	Minimum[b]	Average				Maximum[a]	Minimum[b]	Average	
HP-31	26	750	33	250	0.25	HP-51	26	630	44	240	0.24
HP-32	26	750	33	280	.28	HP-52	26	810	29	290	.29
HP-33	26	710	21	200	.20	HP-53	26	720	41	260	.26
HP-34	26	590	26	240	.24	HP-54	26	710	25	260	.26
HP-35	26	600	19	250	.25	HP-55	26	970	37	270	.27
HP-36	[d]125	800	15	290	.29	HP-56	25	660	11	260	.26
HP-37	26	600	23	220	.22	HP-57	26	810	40	250	.25
HP-38	26	610	34	250	.25	HP-58	25	730	30	290	.29
HP-39	26	790	8	290	.29						
Summary	333	800	8	250	0.25	Summary	206	970	11	270	0.27

[a] Maximum weekly average concentration.
[b] Minimum weekly average concentration.
[c] The applicable AEC Radiation Protection Standard is 100 pCi/m³.
[d] Sample frequency—5 days per week.

XUM

Table 4. Long-lived gross alpha radioactivity of particulates in air, Oak Ridge area, January–June 1970

Perimeter stations						Remote stations					
Station number (figure 3)	Number of samples	Concentration (fCi/m³)			Percent of AEC standard[c]	Station number (figure 2)	Number of samples	Concentration (fCi/m³)			Percent of AEC standard[c]
		Maximum[a]	Minimum[b]	Average				Maximum[a]	Minimum[b]	Average	
HP-31	26	4	<1	1	0.05	HP-51	26	4	<1	1	0.05
HP-32	26	17	<1	4	.20	HP-52	26	5	<1	2	.10
HP-33	26	6	<1	1	.05	HP-53	26	6	<1	1	.05
HP-34	26	5	<1	2	.10	HP-54	26	5	<1	2	.10
HP-35	26	5	<1	1	.05	HP-55	26	5	<1	1	.05
HP-36	[d]125	8	<1	3	.15	HP-56	25	4	<1	1	.05
HP-37	26	4	<1	1	.05	HP-57	26	5	<1	1	.05
HP-38	26	8	<1	2	.10	HP-58	25	6	<1	2	.10
HP-39	26	8	<1	1	.05						
Summary	333	17	<1	2	0.10	Average	206	6	<1	1	0.05

[a] Maximum weekly average concentration.
[b] Minimum weekly average concentration.
[c] The applicable AEC Radiation Protection Standard for natural uranium in air is 2 pCi/m³.
[d] Sample frequency—5 days per week.

eter monitoring stations and analyzed for iodine-131. Of these, the maximum concentration detected was 0.052 pCi/m³, the minimum was less than 0.01 pCi/m³, and the average was 0.01 pCi/m³. The radiation protection standard specified in the AEC Manual for iodine-131 in the ambient atmosphere in uncontrolled areas is 100 pCi/m³.

Milk monitoring

Raw milk is monitored for iodine-131 and strontium-90 by the collection and analysis of samples from 12 sampling stations located within a radius of 50 miles of ORNL. Samples are collected weekly at each of eight stations located on the fringe of the Oak Ridge area. Four stations, located more remotely with respect to the Oak Ridge operations, are sampled at a rate of one station each week. The purpose of the milk sampling program is twofold: first, samples collected in the immediate vicinity of the Oak Ridge area provide data by which one may evaluate possible exposure to the neighboring population resulting from waste releases from Oak Ridge operations; second, samples collected at the more remote stations provide background data which are essential in establishing the proper index for the evaluation of data obtained from local samples. The concentrations of iodine-131 and strontium-90 detected in raw milk samples during the period are given in table 5.

Table 5. Radionuclides in raw milk, Oak Ridge area January–June 1970

Radionuclide and location	Concentration (pCi/liter)		
	Maximum	Minimum[a]	Average
Iodine-131:			
Immediate environs	27	<10	<10
Remote environs	<10	<10	<10
Strontium-90:			
Immediate environs	39	2.0	11.2
Remote environs	17	< 2.0	8.9

[a] The minimum detectable concentrations of iodine-131 and strontium-90 in milk are 10 pCi/liter and 2 pCi/liter, respectively. In averaging, one-half of the minimum detectable concentration was used for all samples showing an activity less than this concentration.

Water monitoring

Large volume, low-level wastes originating at ORNL are discharged, after some preliminary treatment, into the Tennessee River system by way of White Oak Creek and the Clinch River. Liquid wastes originating at the ORGDP and Y-12 Plant are discharged to Poplar Creek and thence to the Clinch River. Releases are controlled so that resulting average concentrations in the Clinch River comply with AEC radiation protection standards. The radioactivity concentration from White Oak Creek is measured, and concentration values for the Clinch River are calculated on the basis of the dilution provided by the river.

Water samples are taken at a number of locations in the Clinch River, beginning at a point

above the entry of wastes into the river and ending at Center's Ferry near Kingston, Tenn. Stream gauging operations are carried on continuously to obtain dilution factors for calculating the probable concentrations of wastes in the river. Samples are analyzed for the long-lived beta-particle emitters, uranium, and the transuranic alpha-particle emitters. The average concentrations of major radionuclides in the Clinch River are given in table 6 for the period from January–June 1970.

Table 6. Concentrations of major radionuclides in the Clinch River, January–June 1970

Radionuclide	Average concentration (pCi/liter)			
	Location on Clinch River[a]			
	Mile 23.1 (Upstream)	Mile 20.8[b] (Outfall)	Mile 14.5	Mile 4.5 (Downstream)
Strontium-90	0.6	0.6	1.8	1.3
Cerium-144	.2	< .1	.4	.3
Cesium-137	.7	.3	2.2	2.9
Ruthenium-103, 106	.3	.2	1.6	.3
Cobalt-60	.6	.2	2.2	1.7
Zirconium-niobium-95	.4	< .1	.4	.4
Tritium	2,250	1,900	5,300	3,100

[a] The location on Clinch River is given in terms of the distance upstream from the Tennessee River (figure 1).
[b] Values given for this location are calculated values based on the concentrations of waste released from White Oak Dam and the dilution afforded by the Clinch River. They do not include radioactive materials (e.g., fallout) that may enter the river upstream from Mile 20.8.

Two quarterly composite water samples from the Clinch River were analyzed for uranium during this period. For these samples, the uranium concentrations were less than 1 pCi/liter, the level of detectability. The AEC radiation protection standard for natural uranium in water released to unrestricted areas is 20 nCi/liter.

Gamma measurements

External gamma radiation levels are measured monthly at a number of locations in the Oak Ridge area. Measurements are taken with a Geiger-Mueller tube at a distance of 3 feet above the ground. The results are shown in table 7.

Discussion of data

The average air contamination levels for gross beta radioactivity, as shown by the continuous air monitoring filter data, for both the immediate and remote environs of the plants (figures 2 and 3) were 0.25 percent and 0.27 percent, respectively, of the AEC radiation protection standard for uncontrolled areas.

The average air contamination levels for gross alpha radioactivity, as shown by the continuous air monitoring filter data, for the immediate and remote environs of the plants were 0.10 percent and 0.05 percent, respectively, of the AEC radiation protection standard for natural uranium for uncontrolled areas.

The average concentration of iodine-131 in air in the immediate environs of the plants was 0.01 pCi/m^3. This is approximately 0.01 percent of the AEC radiation standard for uncontrolled areas.

The average concentrations of iodine-131 in raw milk in the immediate and remote environs of the Oak Ridge area were both less than 10 pCi/liter. These levels fall within the limits of FRC Range I, if the average intake per individual is assumed to be 1 liter of milk per day.

The average concentrations of strontium-90 in raw milk in the immediate and remote environs

Table 7. External gamma radiation levels,[a] Oak Ridge area, January–June 1970

Location	Exposure (mR/h)						
	January	February	March	April	May	June	Average
Kerr Hollow Gate	0.009	0.009	0.023	0.014	0.013	0.011	0.013
Y-12, East Portal	.011	.013	.015	.013	.011	.011	.012
Newcomb Road	.011	.016	.011	.010	.014	.014	.013
Gallaher Gate	.012	.018	.013	.009	.013	.019	.014
White Wing Gate	.015	.010	.024	.011	.013	.012	.014

[a] The background in the Oak Ridge area, determined in 1943, was approximately 0.012 mR/h.

XUM

of the controlled areas was 11.2 pCi/liter and 8.9 pCi/liter, respectively. The average falls within the limits of FRC Range I for transient rates of daily intake of strontium-90 for application to the average of suitable samples of an exposed population.

The percent maximum concentration of radioactivity in the Clinch River at all points of measurements was less than 1 percent of the AEC radiation protection standards. The average concentration of transuranic alpha-particle emitters in the Clinch River at Mile 20.8 was 0.08 pCi/liter which is 0.08 percent of the AEC radiation protection standard for water containing a mixture of unknown radionuclides.

The average concentration of natural uranium materials in the Clinch River reflecting the effects of all Oak Ridge plants was less than 0.1 percent of the AEC radiation standard for uranium.

The average external gamma radiation measured in the town of Oak Ridge and at the perimeter of the Oak Ridge areas was 0.013 mR/h, which is approximately the same as that level measured during the period prior to Oak Ridge operations.

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
January–June 1969	May 1970
July–December 1969	August 1971

Reported Nuclear Detonations, October 1971

(Includes seismic signals from foreign test areas)

Announcement was made by the U.S. Atomic Energy Commission of only one U.S. nuclear test during October 1971. This nuclear test was conducted underground by the Atomic Energy Commission at its Nevada Test Site on October 8, 1971, and was of low yield (less than 20 kilotons TNT equivalent).

Seismic signals, presumably from a Soviet underground nuclear explosion, were recorded by the United States on October 9, 1971. The signals originated at approximately 2:00 a.m. (EDT) Saturday morning at the Semipalatinsk nuclear test area, and were equivalent to those of an underground nuclear explosion in the yield range of 20–200 kilotons.

On October 21, 1971, the United States recorded seismic signals, presumably from a Soviet underground nuclear explosion. The signals originated at approximately 2:00 a.m., EDT, at the Semipalatinsk nuclear test area and were equivalent to those of an underground nuclear explosion in the yield range of 20–200 kilotons.

Seismic signals, presumably from a Soviet underground nuclear explosion, were recorded by the United States on October 22, 1971. The signals originated at approximately 1:00 a.m., EDT, in the southern Ural area of the U.S.S.R. and were equivalent to those of an underground nuclear explosion in the yield range of 20–200 kilotons.

Not all of the nuclear detonations in the United States are announced immediately, therefore, the information in this section may not be complete. A complete list of announced U. S. nuclear detonations may be obtained upon request from the Division of Public Information, U. S. Atomic Energy Commission, Washington, D. C. 20545.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1971-484-491/4

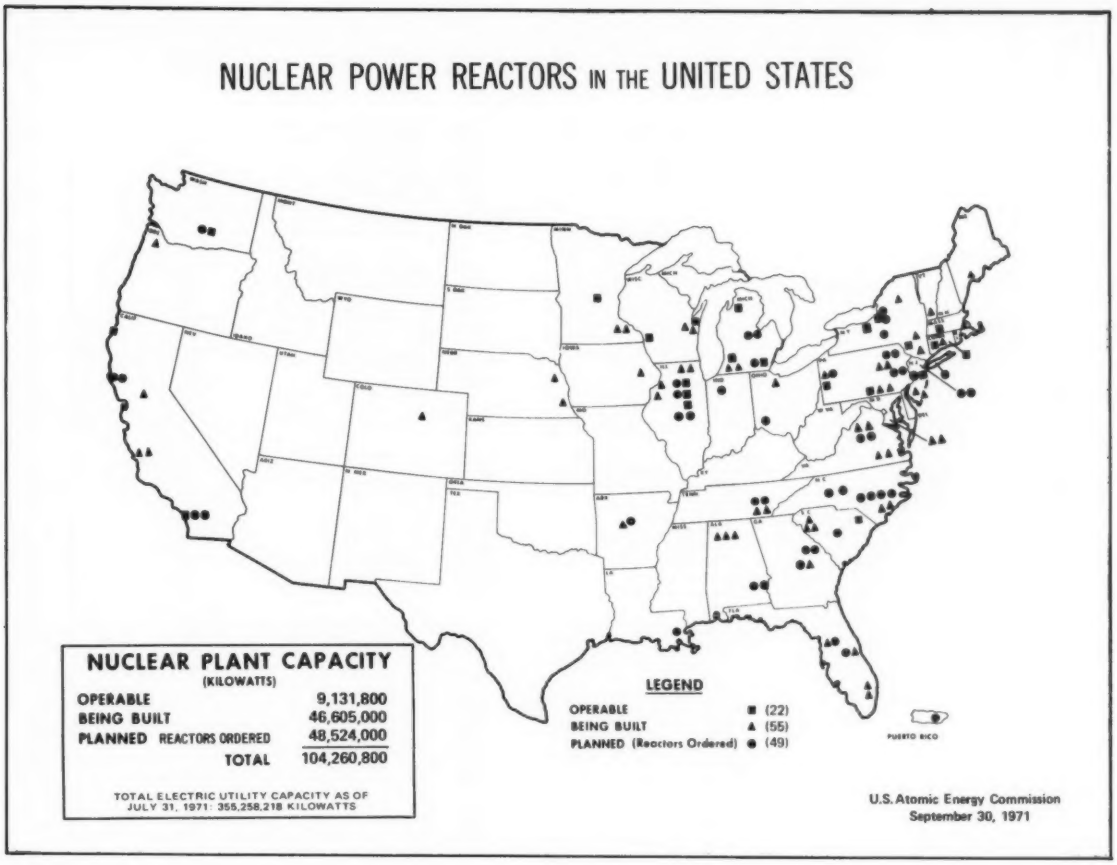

Figure 1. Nuclear power reactors in the United States September 30, 1971

Nuclear Power Reactors in the United States September 30, 1971

Each quarter year, the Atomic Energy Commission releases information on the status of all present and proposed civilian nuclear power generating units in the United States. This information is reproduced for interested readers of Radiological Health Data and Reports.

SITE	PLANT NAME	CAPACITY (Net Kilowatts)	UTILITY	INITIAL DESIGN POWER
ALABAMA				
Decatur	Browns Ferry Nuclear Power Plant: Unit 1	1,065,000	Tennessee Valley Authority	1972
Decatur	Browns Ferry Nuclear Power Plant: Unit 2	1,065,000	Tennessee Valley Authority	1973
Decatur	Browns Ferry Nuclear Power Plant: Unit 3	1,065,000	Tennessee Valley Authority	1973
Dothan	Joseph M. Farley Nuclear Plant: Unit 1	829,000	Alabama Power Co.	1975
Dothan	Joseph M. Farley Nuclear Plant: Unit 2	829,000	Alabama Power Co.	1977
ARKANSAS				
Russellville	Arkansas Nuclear One: Unit 1	820,000	Arkansas Power & Light Co.	1973
Russellville	Arkansas Nuclear One: Unit 2	920,000	Arkansas Power & Light Co.	1975
CALIFORNIA				
Humboldt Bay	Humboldt Bay Power Plant: Unit 3	68,500	Pacific Gas and Electric Co.	1963
San Clemente	San Onofre Nuclear Generating Station: Unit 1	430,000	So. Calif. Ed. & San Diego Gas & El. Co.	1967
San Clemente	San Onofre Nuclear Generating Station: Unit 2	1,140,000	So. Calif. Ed. & San Diego Gas & El. Co.	1975
San Clemente	San Onofre Nuclear Generating Station: Unit 3	1,140,000	So. Calif. Ed. & San Diego Gas & El. Co.	1976
Diablo Canyon	Diablo Canyon Nuclear Power Plant: Unit 1	1,060,000	Pacific Gas and Electric Co.	1974
Diablo Canyon	Diablo Canyon Nuclear Power Plant: Unit 2	1,060,000	Pacific Gas and Electric Co.	1975
Clay Station	Rancho Seco Nuclear Generation Station	804,000	Sacramento Municipal Utility District	1973
Mendocino County	Mendocino Power Plant: Unit 1	1,128,000	Pacific Gas & Electric Co.	1978
Mendocino County	Mendocino Power Plant: Unit 2	1,128,000	Pacific Gas & Electric Co.	1979
COLORADO				
Platteville	Ft. St. Vrain Nuclear Generating Station	330,000	Public Service Co. of Colorado	1972
CONNECTICUT				
Haddam Neck	Haddam Neck Plant	575,000	Conn. Yankee Atomic Power Co.	1967
Waterford	Millstone Nuclear Power Station: Unit 1	652,100	Northeast Utilities	1970
Waterford	Millstone Nuclear Power Station: Unit 2	828,000	Northeast Utilities	1974
FLORIDA				
Turkey Point	Turkey Point Station: Unit 3	693,000	Florida Power & Light Co.	1971
Turkey Point	Turkey Point Station: Unit 4	693,000	Florida Power & Light Co.	1972
Red Level	Crystal River Plant: Unit 3	858,000	Florida Power Corp.	1972
Red Level	Crystal River Plant: Unit 4	897,000	Florida Power Corp.	1978
Ft. Pierce	Hutchinson Island: Unit 1	800,000	Florida Power and Light Co.	1974
Ft. Pierce	Hutchinson Island: Unit 2	800,000	Florida Power and Light Co.	1976
GEORGIA				
Baxley	Edwin I. Hatch Nuclear Plant: Unit 1	786,000	Georgia Power Co.	1973
Baxley	Edwin I. Hatch Nuclear Plant: Unit 2	786,000	Georgia Power Co.	1976
Hancock Landing	—	1,100,000	Georgia Power Co.	1978
Hancock Landing	—	1,100,000	Georgia Power Co.	1979
ILLINOIS				
Morris	Dresden Nuclear Power Station: Unit 1	200,000	Commonwealth Edison Co.	1960
Morris	Dresden Nuclear Power Station: Unit 2	809,000	Commonwealth Edison Co.	1970
Morris	Dresden Nuclear Power Station: Unit 3	809,000	Commonwealth Edison Co.	1971
Zion	Zion Nuclear Plant: Unit 1	1,050,000	Commonwealth Edison Co.	1972
Zion	Zion Nuclear Plant: Unit 2	1,050,000	Commonwealth Edison Co.	1973
Cordova	Quad-Cities Station: Unit 1	809,000	Comm. Ed. Co.-Ia.-Ill. Gas & Elec. Co.	1971
Cordova	Quad-Cities Station: Unit 2	809,000	Comm. Ed. Co.-Ia.-Ill. Gas & Elec. Co.	1972
Seneca	LaSalle Co. Nuclear Station: Unit 1	1,078,000	Comm. Ed. Co.-Ia.	1975
Seneca	LaSalle Co. Nuclear Station: Unit 2	1,078,000	Comm. Ed. Co.-Ia.	1976
•	—	1,100,000	Comm. Edison Co.	1978
•	—	1,100,000	Comm. Edison Co.	1979
INDIANA				
Dune Acres	Bailly Generating Station	660,000	Northern Indiana Public Service Co.	1976
IOWA				
Cedar Rapids	Duane Arnold Energy Center: Unit 1	529,700	Iowa Electric Light and Power Co.	1973
LOUISIANA				
Taft	Waterford Generating Station: Unit 1	1,165,000	Louisiana Power & Light Co.	1976
MAINE				
Wiscasset	Maine Yankee Atomic Power Plant	790,000	Maine Yankee Atomic Power Co.	1972
MARYLAND				
Lusby	Calvert Cliffs Nuclear Power Plant: Unit 1	845,000	Baltimore Gas and Electric Co.	1973
Lusby	Calvert Cliffs Nuclear Power Plant: Unit 2	845,000	Baltimore Gas and Electric Co.	1974
MASSACHUSETTS				
Rowe	Yankee Nuclear Power Station	175,000	Yankee Atomic Electric Co.	1961
Plymouth	Pilgrim Station	655,000	Boston Edison Co.	1972
MICHIGAN				
Big Rock Point	Big Rock Point Nuclear Plant	70,300	Consumers Power Co.	1963
South Haven	Palisades Nuclear Power Station	700,000	Consumers Power Co.	1971
Lagoona Beach	Enrico Fermi Atomic Power Plant: Unit 1	60,900	Detroit Edison Co.	1970
Lagoona Beach	Enrico Fermi Atomic Power Plant: Unit 2	1,123,000	Detroit Edison Co.	1974
Bridgman	Donald C. Cook Plant: Unit 1	1,054,000	Indiana & Michigan Electric Co.	1973
Bridgman	Donald C. Cook Plant: Unit 2	1,060,000	Indiana & Michigan Electric Co.	1974
Midland	Midland Nuclear Power Plant: Unit 1	492,000	Consumers Power Co.	1976
Midland	Midland Nuclear Power Plant: Unit 2	818,000	Consumers Power Co.	1977
MINNESOTA				
Monticello	Monticello Nuclear Generating Plant	545,000	Northern States Power Co.	1971
Red Wing	Prairie Island Nuclear Generating Plant: Unit 1	530,000	Northern States Power Co.	1972
Red Wing	Prairie Island Nuclear Generating Plant: Unit 2	530,000	Northern States Power Co.	1974
NEBRASKA				
Fort Calhoun	Ft. Calhoun Station: Unit 1	457,400	Omaha Public Power District	1972
Brownville	Cooper Nuclear Station	778,000	Nebraska Public Power District and Iowa Power and Light Co.	1973

Figure 1. Nuclear power reactors in the United States—continued

XUM

SITE	PLANT NAME	CAPACITY (Net Kilowatts)	UTILITY	INITIAL DESIGN POWER
NEW JERSEY				
Toms River	Oyster Creek Nuclear Power Plant: Unit 1	560,000	Jersey Central Power & Light Co.	1969
Lacey Township	Forked River Generating Station: Unit 1	1,140,000	Jersey Central Power & Light Co.	1977
Salem	Salem Nuclear Generating Station: Unit 1	1,090,000	Public Service Electric and Gas, N. J.	1973
Salem	Salem Nuclear Generating Station: Unit 2	1,115,000	Public Service Electric and Gas, N. J.	1974
Bordentown	Newbold Nuclear Generating Station: Unit 1	1,088,000	Public Service Electric and Gas, N. J.	1975
Bordentown	Newbold Nuclear Generating Station: Unit 2	1,088,000	Public Service Electric and Gas, N. J.	1977
NEW YORK				
Indian Point	Indian Point Station: Unit 1	265,000	Consolidated Edison Co.	1963
Indian Point	Indian Point Station: Unit 2	873,000	Consolidated Edison Co.	1972
Indian Point	Indian Point Station: Unit 3	965,000	Consolidated Edison Co.	1973
Scriba	Nine Mile Point Nuclear Station: Unit 1	625,000	Niagara Mohawk Power Co.	1970
Scriba	Nine Mile Point Nuclear Station: Unit 2	1,100,000	Niagara Mohawk Power Co.	1977
Rochester	R. E. Ginna Nuclear Power Plant: Unit 1	420,000	Rochester Gas & Electric Co.	1970
Brookhaven	Shoreham Nuclear Power Station	819,000	Long Island Lighting Co.	1975
Lansing	Bell Station	838,000	New York State Electric & Gas Co.	1978
Verplanck	Con. Ed. Nuclear #4	1,115,000	Consolidated Edison Co.	1977
Scriba	James A. Fitzpatrick Nuclear Power Plant	821,000	Power Authority of State of N. Y.	1973
NORTH CAROLINA				
Southport	Brunswick Steam Electric Plant: Unit 1	821,000	Carolina Power and Light Co.	1975
Southport	Brunswick Steam Electric Plant: Unit 2	821,000	Carolina Power and Light Co.	1974
Cowans Ford Dam	Wm. B. McGuire Nuclear Station: Unit 1	1,150,000	Duke Power Co.	1975
Cowans Ford Dam	Wm. B. McGuire Nuclear Station: Unit 2	1,150,000	Duke Power Co.	1977
Bonsal	Shearon Harris Plant: Unit 1	915,000	Carolina Power & Light Co.	1977
Bonsal	Shearon Harris Plant: Unit 2	915,000	Carolina Power & Light Co.	1978
Bonsal	Shearon Harris Plant: Unit 3	915,000	Carolina Power & Light Co.	1979
Bonsal	Shearon Harris Plant: Unit 4	915,000	Carolina Power & Light Co.	1980
OHIO				
Oak Harbor	Davis Besse Nuclear Power Station	872,000	Toledo Edison Cleveland Electric Illuminating Co.	1974
Moscow	Wm. H. Zimmer Nuclear Power Station: Unit 1	810,000	Cincinnati Gas & Electric Co.	1974
OREGON				
Prescott	Trojan Station	1,130,000	Portland General Electric Co.	1974
PENNSYLVANIA				
Peach Bottom	Peach Bottom Atomic Power Station: Unit 1	40,000	Philadelphia Electric Co.	1967
Peach Bottom	Peach Bottom Atomic Power Station: Unit 2	1,065,000	Philadelphia Electric Co.	1973
Peach Bottom	Peach Bottom Atomic Power Station: Unit 3	1,065,000	Philadelphia Electric Co.	1974
Pottstown	Limerick Generating Station: Unit 1	1,065,000	Philadelphia Electric Co.	1975
Pottstown	Limerick Generating Station: Unit 2	1,065,000	Philadelphia Electric Co.	1977
Shippingport	Shippingport Atomic Power Station: Unit 1	90,000	Duquesne Light Co.	1957
Shippingport	Beaver Valley Power Station: Unit 1	847,000	Duquesne Light Co. Ohio Edison Co.	1973
Shippingport	Beaver Valley Power Station: Unit 2	847,000	Duquesne Light Co. Ohio Edison Co.	1978
Middletown	Three Mile Island Nuclear Station: Unit 1	831,000	Metropolitan Edison Co.	1972
Middletown	Three Mile Island Nuclear Station: Unit 2	907,000	Jersey Central Power & Light Co.	1974
Berwick	Susquehanna Steam Electric Station: Unit 1	1,052,000	Pennsylvania Power and Light	1978
Berwick	Susquehanna Steam Electric Station: Unit 2	1,052,000	Pennsylvania Power and Light	1980
SOUTH CAROLINA				
Hartsville	H. B. Robinson S. E. Plant: Unit 2	700,000	Carolina Power & Light Co.	1971
Seneca	Oconee Nuclear Station: Unit 1	841,000	Duke Power Co.	1972
Seneca	Oconee Nuclear Station: Unit 2	886,000	Duke Power Co.	1972
Seneca	Oconee Nuclear Station: Unit 3	886,000	Duke Power Co.	1973
Parr	Virgil C Summer Nuclear Station: Unit 1	900,000	South Carolina Electric & Gas Co.	1977
TENNESSEE				
Daisy	Sequoyah Nuclear Power Plant: Unit 1	1,124,000	Tennessee Valley Authority	1974
Daisy	Sequoyah Nuclear Power Plant: Unit 2	1,124,000	Tennessee Valley Authority	1974
Spring City	Watts Bar Nuclear Plant: Unit 1	1,169,000	Tennessee Valley Authority	1976
Spring City	Watts Bar Nuclear Plant: Unit 2	1,169,000	Tennessee Valley Authority	1977
VERMONT				
Vernon	Vermont Yankee Generating Station	513,900	Vermont Yankee Nuclear Power Corp.	1971
VIRGINIA				
Gravel Neck	Surry Power Station: Unit 1	780,000	Virginia Electric & Power Co.	1972
Gravel Neck	Surry Power Station: Unit 2	780,000	Virginia Electric & Power Co.	1972
Mineral	North Anna Power Station: Unit 1	845,000	Virginia Electric & Power Co.	1974
Mineral	North Anna Power Station: Unit 2	845,000	Virginia Electric & Power Co.	1975
Mineral	North Anna Power Station: Unit 3	900,000	Virginia Electric & Power Co.	1977
Mineral	North Anna Power Station: Unit 4	900,000	Virginia Electric & Power Co.	1978
WASHINGTON				
Richland	N-Reactor/WPPSS Steam	790,300	Atomic Energy Commission	1966
Richland	Hanford No. 2	1,103,000	Washington Public Power Supply System	1977
WISCONSIN				
Genoa	Genoa Nuclear Generating Station	50,000	Dairyland Power Cooperative	1969
Two Creeks	Point Beach Nuclear Plant: Unit 1	497,000	Wisconsin Michigan Power Co.	1971
Two Creeks	Point Beach Nuclear Plant: Unit 2	497,000	Wisconsin Michigan Power Co.	1971
Carlton	Kewaunee Nuclear Power Plant: Unit 1	541,000	Wisconsin Public Service Co.	1972
PUERTO RICO				
Puerto De Jobas	Aguirre Nuclear Power Plant	583,000	Puerto Rico Water Resources Authority	1975
*	–	1,175,000	Tennessee Valley Authority	1977
*	–	1,175,000	Tennessee Valley Authority	1978

* Site not selected.

Figure 1. Nuclear power reactors in the United States—continued

XUM

SYNOPSES

Synopses of reports, incorporating a list of key words, are furnished below in reference card format for the convenience of readers who may wish to clip them for their files.

STRONTIUM-90 IN HUMAN VERTEBRAE IN CZECHOSLOVAKIA, 1964–1969. *Z Březík. Radiological Health Data and Reports, Vol. 12, November 1971*, pp. 541–545.

The Institute of Radiation Hygiene has been conducting a continuous determination of strontium-90 in human vertebrae since the beginning of 1964. Specimens were collected at autopsies of inhabitants of Prague and Middle Bohemia, aged 0–60 years. In the period, 1964–1969, about 1,450 specimens were analyzed and the results divided into 12 age groups. The peak strontium-90 level occurred in 1964 in child group 6–11 months. In the following years, the decreasing trend of strontium-90 values is evident especially in child groups. A frequency histogram of values obtained displays a slightly positive skewness in all years of the study. When plotted, the data indicate a log normal distribution.

An editor's note gives a comparison of data during a corresponding period in the United States and some European countries.

KEYWORDS: Czechoslovakia, human vertebrae, strontium-90, strontium-90 to calcium ratios

RESULTS OF A SURVEY OF X RADIATION FROM COLOR TELEVISION RECEIVERS IN THE METROPOLITAN AREA OF SAN JUAN, PUERTO RICO, 1969–1970. *Radiological Health Program, Commonwealth of Puerto Rico Department of Health. Radiological Health Data and Reports, Vol. 12, November 1971*, pp. 547–551.

In 1969–1970, the Puerto Rico Department of Health surveyed 1,276 color television sets for emission of radiation. Only 34 (2.7 percent) of these sets were found to be emitting radiation in excess of 0.5 mR/h at 5 cm from the surface of the receiver.

KEYWORDS: Color television, Puerto Rico, survey, x-radiation.

ORDER BLANK FOR RHD&R

To: Superintendent of Documents
Government Printing Office
Washington, D.C. 20402

Please enter my subscription for Radiological Health Data and Reports. I am enclosing Money Order ☐ Check ☐ for this subscription. ($6.00 a year; $1.50 additional for foreign mailing.)

Please address RHD&R as follows. _____

_____

_____

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON, D.C., 1971
For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402
Subscription price $6.00 a year, $1.50 additional for foreign mailing.
Price for a single copy of this issue is 50 cents

November 1971

XUM

GUIDE FOR AUTHORS

The editorial staff invites reports and technical notes containing information related to radiological health. Proposed reports and notes should contain data and interpretations. All accepted manuscripts are subject to copy editing with approval of the author. The author is responsible for all statements made in his work.

Manuscripts are received with the understanding that other identical manuscripts are not under simultaneous consideration nor have appeared in any other publication.

The mission of *Radiological Health Data and Reports* is stated on the title page. It is suggested that authors read it for orientation of subject matter.

Submission of manuscripts

Send original and one legible copy of the paper, typed double-spaced on 8½ by 11-inch white bond with 1-inch margins.

Submitted manuscripts should be sent to Editor, Radiological Health Data and Reports, EPA, Office of Radiation Programs, Parklawn 18 B-40, Washington, D.C. 20460.

Preparation of manuscripts

The Government Printing Office style manual is used as a general guide in the preparation of all copy for *Radiological Health Data and Reports*. In addition, *Radiological Health Data and Reports* has developed a "Guide" regarding manuscript preparation which is available upon request. However, for most instances, past issues of *Radiological Health Data and Reports* would serve as a suitable guide in preparing manuscripts.

Titles, authors: Titles should be concise and informative enough to facilitate indexing. Names of authors should appear on the third line below the manuscript title. Affiliation of each author should be given by a brief footnote including titles, professional connections at the time of writing, present affiliation if different, and present address.

Abstracts: Manuscripts should include a 100- to 150-word abstract which is a factual (not descriptive) summary of the work. It should clearly and concisely state the purpose of the investigation, methods, results and conclusions. Findings that can be stated clearly and simply should be given rather than to state that results were obtained.

A list of suggested keywords (descriptors) which are appropriate indexing terms should be given following the abstract.

Introductory paragraph: The purpose of the investigation should be stated as early as possible in the introductory paragraph.

Methods: For analytical, statistical, and theoretical methods that have appeared in published literature a general description with references to sources is sufficient. New methods should be described clearly and concisely with emphasis on new features. Both old and new methods, materials, and equipment, should be described clearly enough so that limitations of measurements and calculations will be clear to the readers. Errors associated with analytical measurements and related calculations should be given either as general estimates in the text or for specific data in appropriate tables or graphs whenever possible.

Illustrations: Glossy photographic prints or original illustrations suitable for reproduction which help enhance the understanding of the text should be included with the manuscript. Graphic materials should be of sufficient size so that lettering will be legible after reduction to printed page size (8½ by 6½ inches).

All illustrations should be numbered and each legend should be typed double-spaced on a separate sheet of paper. Legends should be brief and understandable without reference to text. The following information should be typed on a gummed label or adhesive strip and affixed to the back of each illustration: figure number, legend, and title of manuscript or name of senior author.

Tables: Tables should be self-explanatory and should supplement, not duplicate, the text. Each table should be typed on a separate sheet, double-spaced. All tables must be numbered consecutively beginning with 1, and each must have a title.

Equations: All equations must be typewritten, preferably containing symbols which are defined immediately below the equation. The definition of symbols should include the units of each term. Special symbols, such as Greek letters, may be printed carefully in the proper size, and exponents and subscripts should be clearly positioned. Mathematical notations should be simple, avoiding when feasible such complexities as fractions with fractions, subscripts with subscripts, etc.

Symbols and units: The use of internationally accepted units of measurements is preferred. A brief list of symbols and units commonly used in *Radiological Health Data and Reports* is given on the inside front cover of every issue and examples of most other matters of preferred usage may be found by examining recent issues. Isotope mass numbers are placed at the upper left of elements in long series or formulas, *e.g.*, ^{137}Cs; however, elements are spelled out in text and tables, with isotopes of the elements having a hyphen between element name and mass number; *e.g.*, strontium-90.

References: References should be typed on a separate sheet of paper.

Personal communications and unpublished data should not be included in the list of references. The following minimum data for each reference should be typed double-spaced: names of all authors in caps, complete title of article cited, name of journal abbreviated according to *Index Medicus*, volume number, first and last page numbers, month or week of issue, and year of publication. They should be arranged according to the order in which they are cited in the text, and not alphabetically. All references must be numbered consecutively.

Reprints

Contributors are ordinarily provided with 50 courtesy copies of the articles in the form of reprints. In cases of multiple authorship, additional copies will be provided for coauthors upon request.

ENVIRONMENTAL
PROTECTION AGENCY
OFFICE OF RADIATION PROGRAMS
WASHINGTON, D.C. 20460

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
ENVIRONMENTAL PROTECTION
AGENCY

Please CHECK if you do not desire to continue receiving this publication ☐; or, if a change of address is needed ☐ (indicate change, including zip code); tear off this cover and return to the above address.

XUM